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GUIDE

TO THE

EXHIBITED SERIES OF INSECTS

IN THE DEPARTMENT OF ENTOMOLOGY

BRITISH MUSEUM (NATURAL HISTORY)

CROMWELL ROAD, LONDON, S.W.7.

(FOURTH EDITION)

B. M.
(N.H.)

WITH 62 ILLUSTRATIONS

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PREFACE TO THE FOURTH EDITION.

In preparing the Fourth Edition of this Guide, little has been added to what had appeared in the Third Edition, which is now out of print, but opportunity has been taken to make a few slight alterations and corrections in the text.

It may be desirable to point out here that in addition to the series of Insects exhibited in the Gallery to which this Guide relates, there is a series of species of economic importance exhibited in the North Hall. To the specimens and models of Insects and Ticks shown in the Central Hall a Special Guide—No. 7—has been published, of which a new edition is now in course of preparation.

CHARLES J. GAHAN,
Keeper of Entomology.

British Museum (Natural History),
March, 1926.

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GUIDE

TO THE

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THE specimens of insects exhibited in the gallery are only a very small representative series. The main collection for the purpose of study is kept in cabinets in the Insect Room in the basement. It is estimated to contain not less than 3,500,000 specimens, and comprises about 250,000 named species.

The specimens are in table-cases placed down the centre of the gallery, numbered 29 to 56. The large specimens which are unsuitable for the table-cases are placed in the wall-cases at the sides of the gallery.

On each side of the gallery will be seen models (1–85) arranged on shelves, to illustrate the life histories of various insects. Where possible, species likely to be of interest from agricultural or horticultural points of view have been chosen. Nos. 11–21 are *Aphidæ* and other Homoptera. Attention is called to the three rose galls of *Rhodites eglanteriæ*, *nervosus* and *rosæ* (23, 25, 27). The reason why these three insects, which are so much alike that they require an expert to separate them, produce such different galls has never been satisfactorily explained. The series of galls made by Gall-flies (*Cynipidæ*, 29–47) is particularly deserving of careful attention. To understand the series of oak galls (29–43), it must be borne in mind that the males only exist in alternate generations, and that the females which appear in the same generation as the males are often so different from the females of the previous and following generations that until this fact was known the insects were placed in different genera. Hence there exists a double set of names for the same species, and these are still used, but as a matter of convenience only. The common "oak-apple" (39) is a very good example. The males and females that come out of these are called *Andricus terminalis*. These females deposit their eggs on the roots of the oak, and produce

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small woody galls. From these root galls comes in the winter a much larger wingless insect, called *Biorhiza aptera*. These are all females. They crawl up the tree and deposit their eggs in the buds, which in the spring develop into the well-known oak-apples.

The marble gall (43) is still an enigma. The insects that come from these, *Cynips Kollari*, are all females. Although this insect is so common, the male has hitherto baffled all efforts to discover it.

Other galls of *Cynipidæ* are one on ground ivy formed by *Aulax glechomæ* (45), and a curious swelling in the stem of bramble formed by *Diastrophus rubi* (47).

On the east side of the gallery will be found models relating to Coleoptera (49–59), Hymenoptera (61–71), Lepidoptera (73–85), and Diptera (87). The larvæ of a great many Phytophagous beetles live on the under sides of leaves, eating the soft parts. The Mustard beetle, *Phædon cochleariæ* (49), sometimes attacks cultivated mustard with disastrous consequences, as the larvæ eat the flower buds as well as the leaves. Another model of great interest is one showing apple-buds injured by the Apple-blossom weevil, *Anthonomus pomorum* (53). The remarkable way in which certain weevils cut and roll leaves to form their nests is illustrated by *Attelabus* (57) on oak, and *Rhynchites* (59) on birch. The models relating to Hymenoptera include cherry injured by Slug-worm, *Blennocampa cerasi* (61); galls on willow formed by another saw-fly, *Nematus gallicola* (63); a third shows the gregarious habits of *Pamphilus flaviventris* (65); the way in which the Leaf-cutting Bee, *Megachile willughbiella* (71) forms its nest is shown by a single cell taken to pieces.

All the models relating to Lepidoptera (73–85) will repay study; perhaps the one that has received the most attention is the oak attacked by *Tortrix viridana* (77), the trees in the spring often being stripped of their leaves by this insect.

The British Insects (including the beautiful collection of Caterpillars of Butterflies and Moths, prepared by the late Lord Walsingham) will be found in cabinets on the west side of the gallery.

The Foreign Insects are on the east side; and, in a cabinet, on that side also, there is exhibited a series of the insects which form the food of trout and grayling.

A large case on the east wall is devoted to a description of the external anatomy of insects. The series is not yet complete.

At the north end of the gallery is a case containing specimens and preparations to illustrate the modifications of structure in insects in relation to flight.

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GENERAL ARRANGEMENT OF GALLERY.

Nests of Ants and Wasps.

Maps illustrating geographical distribution.
Cabinet with British Insects.

Models showing habits of
Gall-flies.
Cabinets of British Lepidoptera.

Moth cocoons,
and
metamorphoses.

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Nests of Wasps and Bees.

Anatomical Case.
Cabinets of foreign Butterflies.

Models showing habits of
Coleoptera and Hymenoptera.
Cabinets of foreign Insects.

Nests of
White Ants.

TABLE CASES.

West Entrance.

East Entrance

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In arranging the gallery the intention has been to begin with the most primitive forms (which are nearest to the Centipedes and Millipedes in the next part of the gallery), and to proceed from these to the higher forms, or those most removed in their structure from the primitive type.

Scientific terms are avoided as much as possible ; but the names of the parts of an insect, having no English equivalents, are shown in a diagram of a Cockroach in the cover of the first table-case. The following words are also in use :—

APTEROUS.—Without wings.

JOINT.—This is applied to the *parts* or segments of the antennæ, palpi and tarsi.

METAMORPHOSES.—The changes undergone by an insect as it grows to maturity.

NEURATION.—The arrangement of the veins or nerves in the wings of an insect.

OVIPOSITOR.—The instrument used by the female insect in depositing eggs.

PUNCTURE.—A mark on a surface as if made with a pointed instrument.

GENICULATE.—Applied to the antennæ of an insect when they are bent at an angle in the middle ; elbowed.

The following diagram (fig. 1) shows the relationship which is believed to exist between the various Orders of insects.

The following is the sequence in which the Orders are placed in the cases :—

Aptera, Orthoptera, Neuroptera, Trichoptera, Lepidoptera, Hymenoptera, Diptera, Coleoptera, Rhynchota.

Class INSECTA.

(Table-cases 29–56.)

Table-case 29.

Insects are animals whose bodies are divided into three regions, called respectively the head, thorax and abdomen. They breathe by means of *tracheæ* or air tubes distributed through the body, but opening externally by means of orifices, called *spiracles*, placed at the sides of the body. They have six legs, which are attached respectively to the three portions or segments of which the

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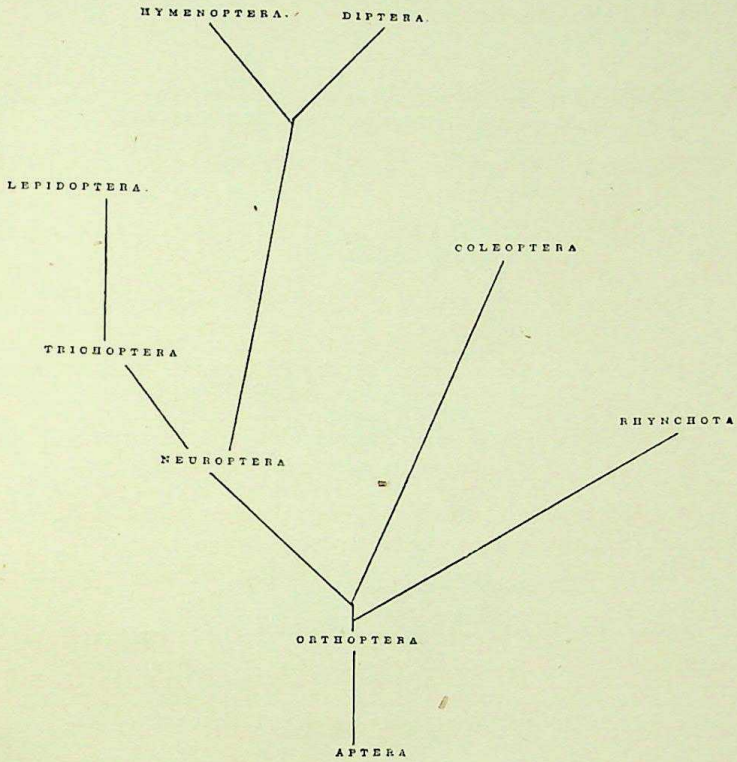
thorax is composed. The head has two antennæ. The majority are provided with two pairs of wings, but some have only one pair, and many have none.

The nervous system consists of two parallel cords down the middle of the lower surface of the body, united at intervals by nerve centres called *ganglia*, from which nerves are sent off to the various

Fig. 1.



parts of the body. In insects of a most primitive type there is a *ganglion* in each segment of the body, but in the higher insects these ganglia are drawn more or less forward, often uniting, especially in the thorax.

Examples of the caterpillar of a Goat-moth (1000), a Hornet (1002), Horse-fly (1004) and Summer Chafer (1006) are exhibited in Table-case 29.

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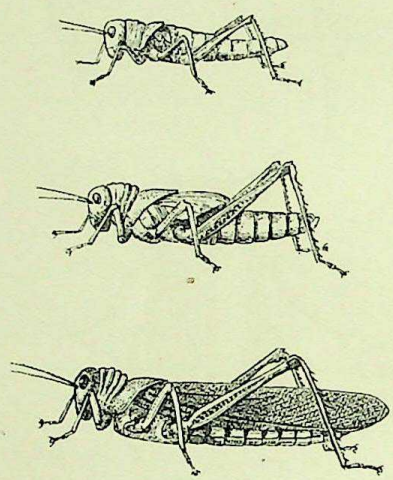
Except in the lowest forms (the *Aptera*), insects undergo metamorphoses, *i.e.*, distinct changes as they grow to maturity. The stages are :—

1. The *egg*.
2. The *larva*. The insect as it leaves the egg; the grub or caterpillar state.
3. The *pupa*. The stage immediately preceding the perfect state; the chrysalis state.
4. The *imago*. The perfect insect.

Insects do not grow after they get to this state.

When the larva and pupa stages are nearly similar, and both

Fig. 2.



Larva, pupa and imago of a Brazilian locust, *Titanacris cristata*; ½ nat. size. (125.)

more or less resemble the perfect insect, the word *nymph* is often used for both.

Table-case 29. Wall-case 8.

In some instances the changes are gradual, not very distinct, and the difference between the larva and perfect insect is slight. When this is the case the insect is said to undergo incomplete metamorphosis. Examples of a large Brazilian locust (*Titanacris cristata*, 125, fig. 2) are exhibited, also a *Eurycantha* (123), *Pseudophyllanax*

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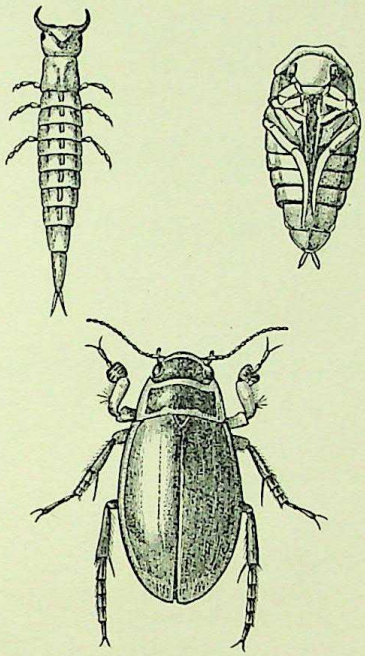
(127), as well as the Neuroptera *Æschna* (119), *Agrion* (121), and examples of large water-boatmen (145, 147).

In other cases the three stages are strongly marked (as, for example, the caterpillar and chrysalis of a moth). In such cases the insect is said to undergo complete metamorphosis.

Specimens of the larva, pupa and imago of a common water-

Fig. 3.



Larva, pupa and imago of a common English water-beetle, *Dytiscus marginalis*. (1010.)

beetle (*Dytiscus marginalis*, 1010, fig. 3) are shown in Table-case 29. Other examples of Coleoptera (129–143), of Neuroptera (111–117), of Lepidoptera (109), of Hymenoptera (101–105), and larvæ of Diptera (107) are shown in Wall-case 8.

In Table-case 30 is a series of insects showing examples of the different Orders, with labels indicating their principal characters. These are not arranged in a line, but (as far as can be) in accordance Table-case 30.

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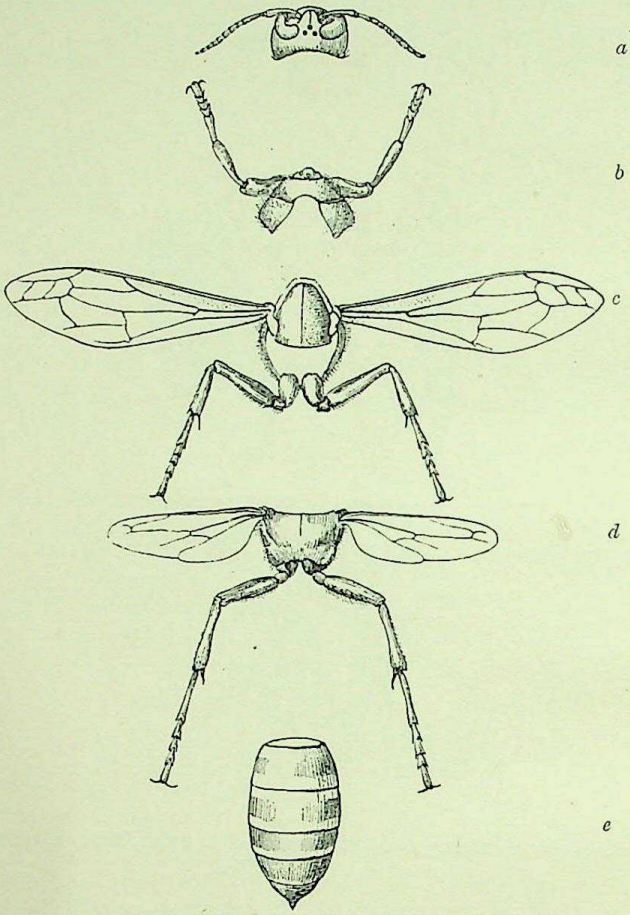
with their relationship as indicated in fig. 1, a copy of which is in the frame which forms the cover of the case.*

Fig. 4.



Hornet (*Vespa crabro*), dissected. (1015.)
a, head; *b*, prothorax; *c*. mesothorax; *d*, metathorax; *e*, abdomen.

The body of an insect is divided into three principal parts,

* As insects fade when exposed to the light, many losing their colours in a few months only, it is necessary to protect them from the light as much as possible. The glazed frames which form the covers should be raised and allowed to rest against the support on the top of the case, and be lowered again when done with.

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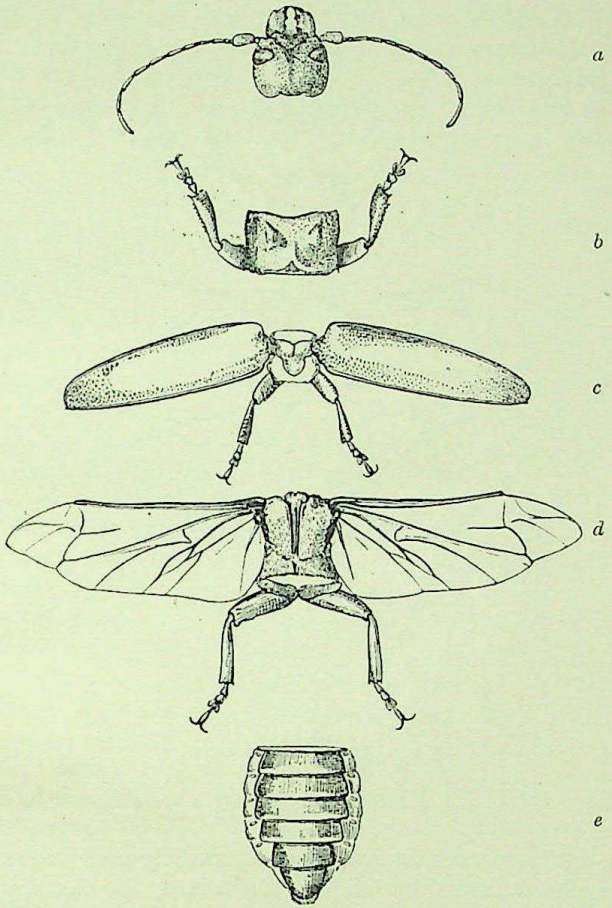
namely, the head, thorax and abdomen, as shown in the diagram of a Cockroach in the cover of Case 1. The head bears a pair of

Fig. 5.



Beetle (*Brephilydia jejunum*), dissected. (1016.)

a, head; *b*, prothorax; *c*, mesothorax; *d*, metathorax; *e*, abdomen.

organs called antennæ, and has two "compound" eyes. It is sometimes imbedded in the thorax as in grasshoppers, beetles, etc.; in other cases it is free, being only attached to the thorax by a membranous neck, as in flies, wasps, etc.

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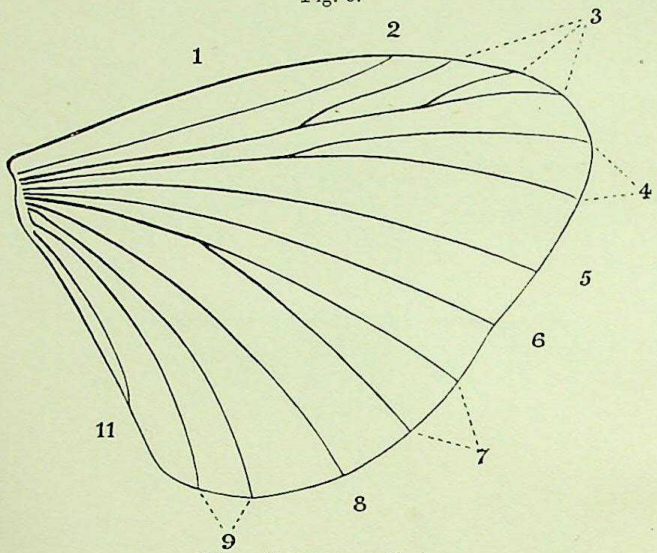
The thorax is composed of three segments called respectively prothorax, mesothorax and metathorax. The relative sizes of these three parts vary greatly, and furnish important characters for purposes of classification. In some it is the prothorax that is greatly developed (as in beetles), but in others it is the mesothorax that is the largest (as in flies, bees, etc.). The prothorax bears the front pair of legs. The mesothorax bears the front pair of wings and the second pair of legs, and the metathorax bears the second pair of wings and the hind pair of legs. Speci-

Fig. 6.



Theoretic diagram of wing.

mens dissected (1015, 1016) to show this are exhibited in Table-case No. 29.

The abdomen generally consists of nine visible rings or segments, but occasionally there are ten, and the number is often less; the reduction in the number is due either to the basal segments becoming membranous and so disappearing or to the apical segments having been modified and withdrawn into the body. The last segment often bears a pair of jointed organs called *cerci*.

In the wings are seen a number of horny rib-like lines, usually called veins, in which the tracheal tubes run. There are nine principal veins, but these often send off branches, especially towards

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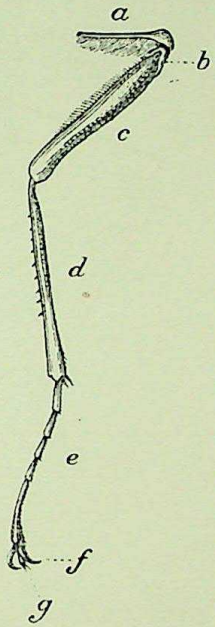
the margin of the wing. Besides these veins there are cross-veins, sometimes few in number, in other cases very numerous, so that (as in the Dragon-flies) the wing has the appearance of network. To avoid confusion these cross-veins are called nervures.

In the classification of insects the way in which the veins are arranged is of great importance. The principal veins have received various names, but as it is, or was, impossible to ascertain the corresponding veins in the different Orders, each author has used the names that best suited his purpose. The names most commonly in use are given in the anatomical case at the end of the gallery. In the diagrams in the table-cases the veins are only numbered and coloured, those that are believed to be homologous being similarly coloured throughout.

Fig. 7.



Leg of a beetle (*Chiasognathus*). (1020.) *a*, coxa; *b*, trochanter; *c*, femur; *d*, tibia; *e*, tarsus; *f*, claw; *g*, onychium (enlarged).

The eyes are of two kinds: simple and compound. The simple eyes, called *ocelli*, are placed on the front or upper part of the head; three is the most usual number, but some insects have only two, and a few only one. They have the appearance of glass beads imbedded in the surface of the head. The compound eyes are placed at the sides of the head. They are termed compound because they consist of a number of lenses, varying from seven to twenty-seven thousands. In some insects these lenses are placed close together, but retain their round form; in others they have the appearance of having been pressed together, so that each lens is six-sided (hexagonal) and the whole eye presents the appearance of a honeycomb.

The legs (1020) are composed of five principal parts: 1, the coxa, which fits into a socket in the body; 2, the trochanter, which in some cases is divided into two; 3, the femur; 4, the tibia; 5, the tarsus, which normally consists of five joints, but sometimes of four or three, and in exceptional cases two or even one. The last joint is provided with a pair of claws, and between these there is often a small piece, which has received various names, such as *pulvillus*, *arolium*, and *onychium*.

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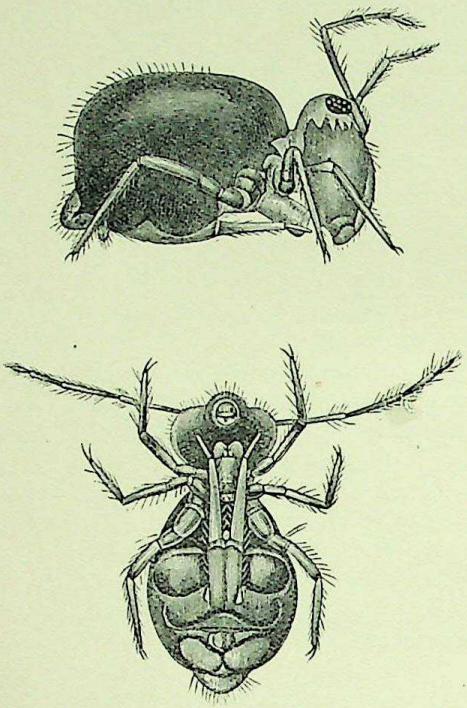
Order APTERA.

Table-case 31.

In Table-case 31 are exhibited examples of the *Aptera*, which include the Springtails and Fish Insects, and are wingless insects which undergo no metamorphoses, the young resembling the adult

Fig. 8.



Springtail (*Papirius*), greatly enlarged (after Lubbock).

except in size. They are usually divided into two sub-orders, *Collembola* and *Thysanura*.

The *Collembola*, or Springtails, are small soft-bodied insects, very common in decaying vegetable matter, on herbage by the roadside, on the banks of ponds, and on the surface of stagnant water. One small white species (*Isotoma fimetaria*) can live equally well on land and on the top of water, and as it can live under water for many weeks it has at times caused some trouble by getting into cisterns.

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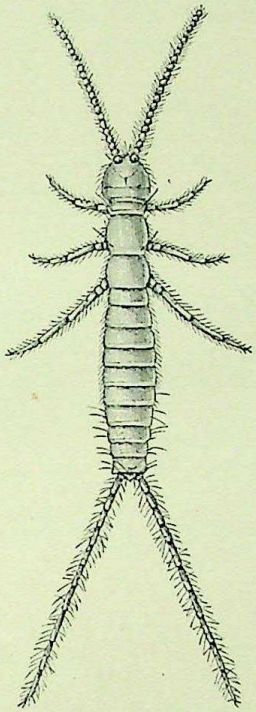
Many of the species are clothed with scales very similar in appearance to the scales on the wings of butterflies.

Their name of Springtail is derived from the fact that many of them possess the power of leaping by means of an appendage lying beneath the body. The lower figure in the illustration (fig. 8) shows

Fig. 9.



Campodea staphylinus, enlarged seven times.

this forked appendage. Some of the genera do not possess this power.

The *Thysanura* are divided into four families: *Campodeidæ*, *Japygidæ*, *Machilidæ*, and *Lepismidæ*, insects which differ greatly in appearance and structure.

The first includes what is perhaps the most primitive of all insects —*Campodea*, a small, nearly white, very active creature, about a quarter of an inch in length, common in garden mould, under dead leaves, etc.

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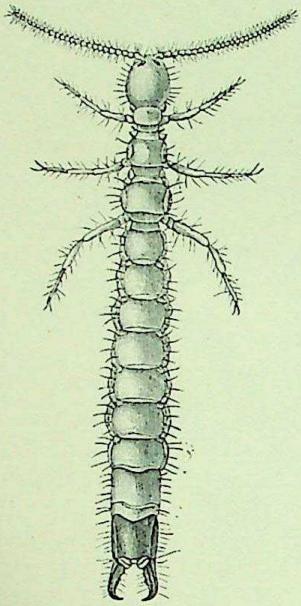
Table-case 31.

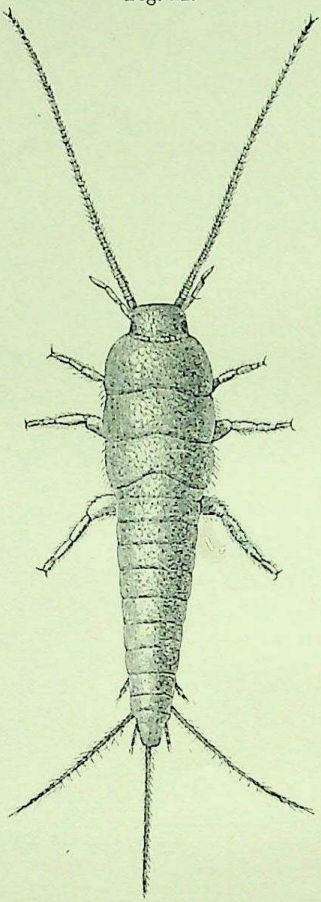
Japyx (1042) somewhat resembles *Campodea*, but the cerci, instead of being long, many-jointed organs, are modified into short strong

Fig. 10.



Japyx solifugus, enlarged nine times.

Fig. 11.



Fish Insect, *Lepisma saccharina*, enlarged six times (after Lubbock). (1050.)

forceps, somewhat as in the Earwigs. There are several species, one being S. European.

Another and much better known member of this sub-order is *Lepisma saccharina* (1050), the Fish Insect. It is about half an

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inch long and when in perfect condition is clothed with silvery-grey scales. It is common in warehouses, clothes presses, and sometimes does considerable mischief to old prints, books, etc., by gnawing away the surface.

An allied insect is *Thermophila furnorum*, of which a drawing is exhibited. It is about half an inch in length, of a yellowish cream colour, prettily ornamented with grey and black scales. It is not often seen, but occasionally occurs in great numbers in London bakeries, hence its name "Baker's Brat."

Order ORTHOPTERA.

In the second half of Case No. 31 the series of *Orthoptera* commences. These are divided into seven families, the principal characters of which are as follows :—

A.	Hind legs formed for running or walking. ORTHOPTERA CURSORIA.	Legs attached to the side of the body by small coxæ. (Fig. 12).	Tarsi 3-jointed.	FORFICULIDÆ. (Earwigs).
			Tarsi 5-jointed.	PHASMIDÆ. (Stick Insects).
		Legs with large, elongate coxæ. (Fig. 13).	Front legs formed for seizing.	MANTIDÆ. (Mantids).
			All the legs formed for running.	BLATTIDÆ. (Cockroaches).
B.	Hind legs formed for leaping. ORTHOPTERA SALTATORIA.	Antennæ long, thread-like.	Tarsi 3-jointed.	GRYLLIDÆ. (Crickets).
			Tarsi 4-jointed.	PHASGONURIDÆ. (Long-horned Grasshoppers).
		Antennæ not very long.		LOCUSTIDÆ. (Locusts and Grasshoppers).

Family HEMIMERIDÆ.

An insect of particular interest in this case is *Hemimerus* (1056), a wingless insect found on a rat or "ground pig" (*Cricetomys gambianus*) and other small mammals in Africa.

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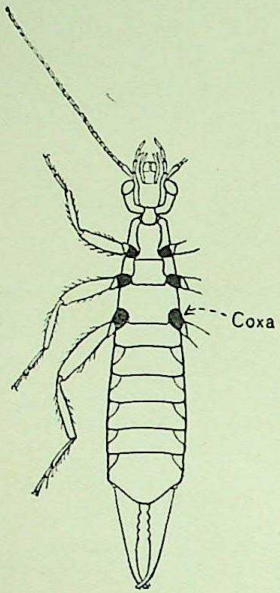
Table-case 31.

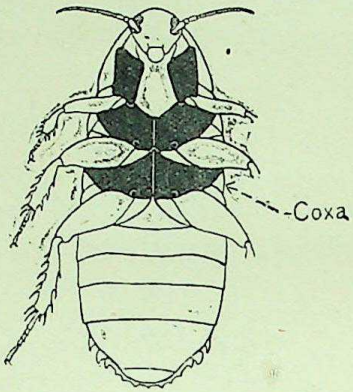
Like most other parasites it is difficult to determine where it should be located in a natural system, and it is therefore placed

Fig. 12.



Under side of an earwig. (1077.)

Fig. 13.



Under side of a cockroach. (1080.)

The coxæ are shaded black.

here immediately after the *Thysanura* and at the head of the *Orthoptera.* It was originally described as allied to the *Gryllidæ* (crickets).

Family FORFICULIDÆ.

Following this are the earwigs, *Forficulidæ* (1060–1069). Of this family there are many hundreds of species, and they are found all over the world. Two are common in Britain, *Forficula auricularia* (1067) and *Labia minor* (1065); the smaller of these, however, is not often seen, as it is chiefly found in manure heaps. One of the chief characteristics of this family is the pair of forceps at the end of the body. The shape of these varies very much, and they are smaller in the female than in the male. They are modifications of the cerci. In the common British and many other species the insect leaves the egg with the forceps already to some extent formed;

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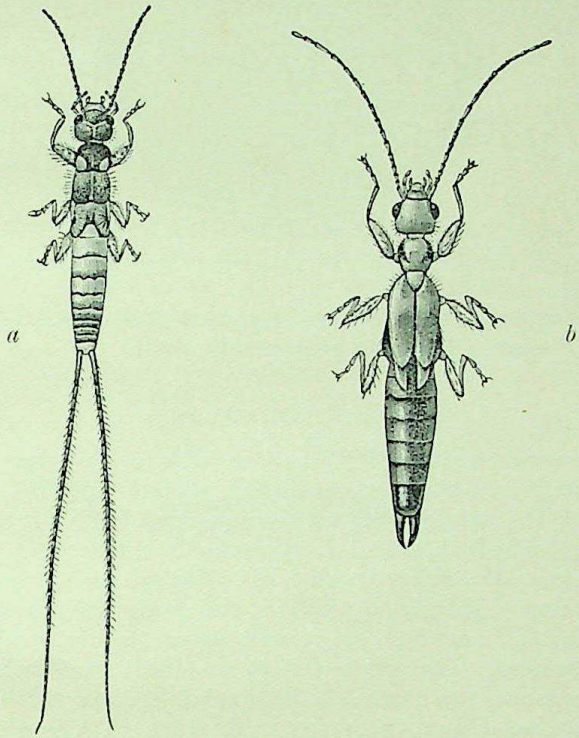
the jointed character of the cerci can, however, be seen while the insect is still in the egg (fig. 15).

In *Diplatys* (1060) from Ceylon, and perhaps in other exotic species, the larva leaves the egg with the cerci of great length (fig. 14, *a*), and these continue until the skin is cast for the last

Fig. 14.



a, Larva, and, *b*, imago of an Earwig, *Diplatys longisetosa*, enlarged six times. (1060.)

time, when the cerci are thrown off and the forceps (which have now formed within them) appear (fig. 14, *b*).

Many earwigs have no wings, but in the majority the front pair are modified into elytra of a leathery texture, with a straight suture, and not or scarcely overlapping. The hind wings are ample, but when at rest are folded beneath the elytra. Both in the way they

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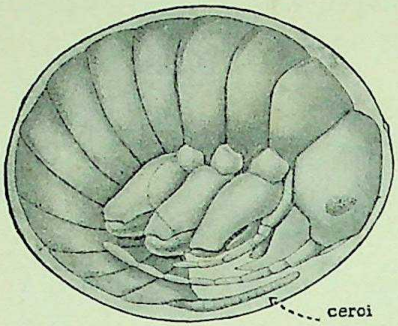
Table-case 31. are folded and in the character of the neuration they are quite unlike those of any other insect.

Fig. 15.



Egg of common earwig, *Forficula auricularia*, greatly enlarged.

The eggs are spherical, leathery, semi-transparent. They are deposited separately in small groups in the earth.

Family PHASMIDÆ.

Table-cases 31, 32. These insects (1070–1096) are remarkable for their resemblance to twigs, sticks, leaves, &c., whence their popular name Stick-insects. Many of the species, such as *Diapheromera* (1081), for example, are wingless in both sexes. In some cases the male has wings, the female none; in *Acrophylla* (1092) and allied species both sexes have ample wings. *Aschiphasma* (1086) is one of the very rare instances in which the front wings are entirely absent, the hind wings being fully developed. The species of *Phyllium* (1094) are remarkable for their resemblance to leaves—this is especially the case in the female. The male has delicate transparent hind wings. The female has no hind wings, but the front ones are considerably developed, and the arrangement of the veins gives them a very leaf-like appearance. It should be observed that this wing consists almost entirely of the part in front of the chief veins, the hinder part (that generally developed in other insects) is reduced to a narrow strip. The male has long antennæ; in the female they are very short.

The eggs of *Phasmidæ* are very remarkable. Some are vase-shaped, others resemble seeds. They are very diverse in form, and even in closely related species such as *Phyllium siccifolium* and

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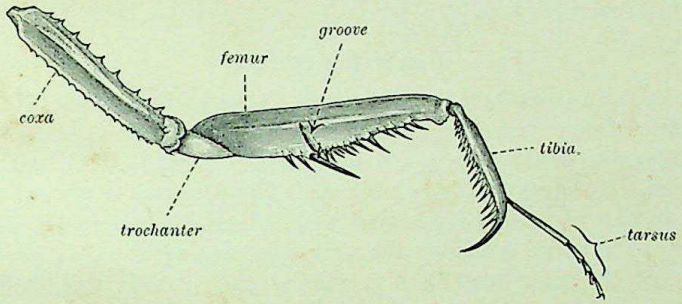
P. pulchrifolium they are quite different. Some examples of the eggs are exhibited (1092, 1094), and enlarged drawings of several are shown in the table cover. As if to complete the resemblance to seeds, many of them have a mark on one side resembling the point of attachment, "*hilum*," of beans, etc. When the young insect comes out of the egg, the top is pushed off like a lid. Table-case 32.

The *Phasmidæ* are vegetable feeders, living on grasses, shrubs and trees, where their curious forms enable them to rest concealed.

Family Mantidæ.

In the second half of table-case No. 32 are a few examples of Mantids. They are carnivorous, feeding chiefly on other insects. They are found in Southern Europe and are common in tropical countries. The European "Praying Mantis" (fig. 16, 1128), derives its name from the habit (common to all the species) of standing on its four hind legs, with the front pair held up and close together. In this attitude they remain until some fly or other insect comes within reach, when the front legs are darted out with lightning rapidity and

Fig. 18.



Leg of a Mantis.

the fly is caught between the spines on the tibiæ and femora. This curious structure of the front legs (fig. 18) is the chief character of this family. It will be noted that the front coxæ are very long, which enables the leg to be thrown forwards. There is a row of spines on the under side of the tibia, and these when the tibia is folded against the femur fit between the spines on the latter, the terminal curved spur resting in a groove on the inner side of the femur.

The colours and curious forms of many of the species are well

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calculated to render them inconspicuous, when waiting among leaves either living or dry, or on the bark of a tree as *Acanthops* does (1137). Some species have bright colours beneath, and at a distance this gives the appearance of a flower which may attract insects. *Idolum diabolicum* (1143) from E. Africa is a good example of this. The colours fade after death, but a plate from the Proceedings of the Cambridge Philosophical Society is exhibited to show the natural colours.

The eggs of *Mantidæ* are laid in a regular manner in flask-shaped receptacles or egg-sacks, each sack containing several eggs. The sacks are arranged one against the other, alternately right and left, the whole series being enclosed in a capsule or envelope (fig. 17A). These capsules have the appearance of being formed of gelatinous matter. They are sometimes compact and hard, sometimes semi-transparent and smooth. Usually the capsule has along the upper side a ridge in which may be seen a number of small holes or slits (fig. 17B). These are the openings of the sacks by which the young escape; they are not always visible. The transparent capsules (1152) have the egg-sacks suspended by the sacks' necks. The capsules are always attached to some object, such as a stone, twig, or stem of grass.

Family Blattidæ.

Table-case 33.

In Table-case 33 are examples of the Cockroaches, *Blattidæ* (1170–1193). One of the chief characteristics of this family is the great development of the coxæ, which occupy nearly the whole of the sternal region. The legs are densely spined. The wings when present are ample, the front pair being leathery and serving as covers for the hind pair. The curve taken by the sixth vein, cutting off all the basal part of the front wing, is a peculiarity only seen in this family. Many species are without wings in both sexes. The female of the common house Cockroach, or "black-beetle" (1177), has no wings, and the females of *Heterogamia ægyptiaca* (1175) (where the differences in the sexes are very great) and of many other species are also wingless. The brown Ship-cockroach, *Periplaneta americana* (1178), has wings in both sexes; in the female, however, they are rather shorter than in the male. An interesting series of this species (1193) is exhibited to show the curious attitudes of the insect when cleaning itself. The antennæ are drawn down by means of the front leg and then passed through the mouth to remove all dust. One specimen has turned its head so as to clean the hind angles of

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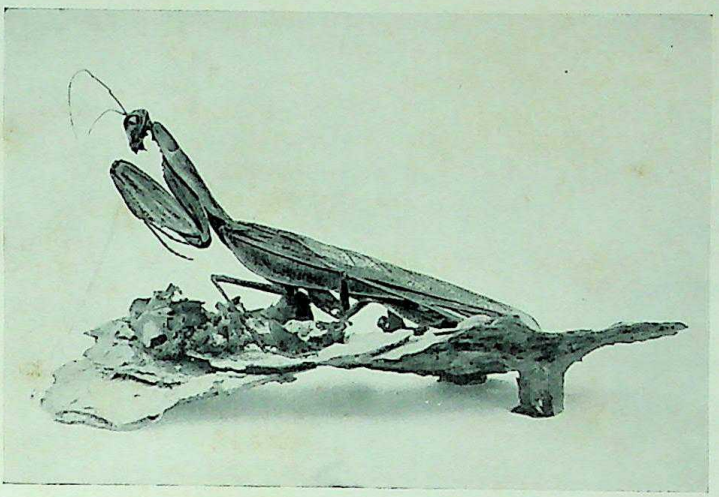
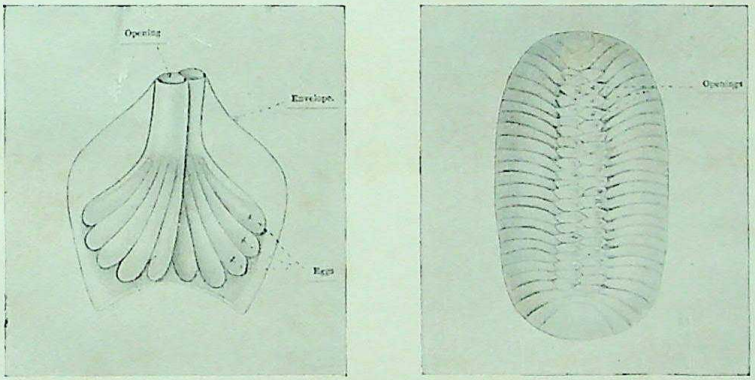
Fig. 16.



SIDE VIEW OF COMMON EUROPEAN MANTIS (1128).
(*Mantis religiosa.*)
(Photographed from a specimen in the Museum.)

A Fig. 17. B



DIAGRAMS SHOWING THE STRUCTURE OF THE EGG-SACK OF A MANTIS.

[*To face p.* 20.

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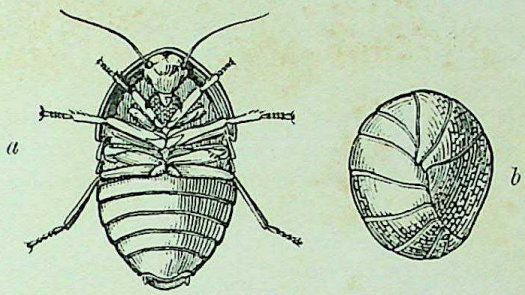
its thorax. One is seen cleaning its under side; another its hind leg. These are all set as they were seen in life.

Another common species is *Phyllodroma germanica* (1172). This insect appears to belong more to Northern Europe. It was rarely met with in England until comparatively recently, but has spread rapidly in London and is now a great pest. There are three British cockroaches which are found in woods and among furze bushes or heaths. These are all small species. Some of the species found in the tropics are of considerable size, especially those of the genus *Blabera* (1186) and *Megaloblatta* (1173), some of which measure nearly six inches in expanse of the wings. Some species bear a close resemblance to Coleoptera. *Phoraspis picta* (1174) and *Corydia*

Fig. 19.



5042

Perisphœria glomeriformis, twice natural size. (1189.)
a, under side; *b*, side view when rolled.

petiveriana (1190) are good mimics of Tortoise-beetles. *Prosoplecta coccinella* resembles a Ladybird (*see* drawing).

Perisphœria (1189) can roll itself up into a ball (after the manner of an Armadillo, or wood-louse); the end segment of the body fits exactly into the front of the prothorax, so that the head and legs are completely hidden and protected (fig. 19).

Female Cockroaches may often be found carrying their eggs in a capsule at the end of the body. The eggs are arranged in this capsule in two rows, upright like sacks, alternately right and left, with a single one at each end, the whole being covered with secretion which hardens into a leathery substance (*see* drawing). The structure is very similar to that of the egg-mass of the *Mantidæ*, but in those each sack contains several eggs; in the *Blattidæ* each sack contains but one egg. The number of eggs in the whole capsule varies.

Panesthia javanica (1192) appears to be viviparous, as the

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Table-case 33.

young are seen to be nearly fully developed in the body of the female exhibited in the case, but whether these leave the body in an active condition or not is still uncertain.

Family GRYLLIDÆ.

The jumping Orthoptera (*Saltatoria*) begin in the second half of this case. The first family is that of the *Gryllidæ*, or Crickets (1201–1212). These are characterised by their long thread-like antennæ, and tarsi composed of three joints only. A few species have only two joints. The tarsi are hairy or spiny beneath, not provided with soft pads as in the following family. The basal joint is very long, and is nearly always furnished with a spine at each apical angle, the one on the inner side being much longer than the other. The species are nearly all of a brownish or horn colour.

The chirping of the common house Cricket and other Crickets is caused by rubbing one wing over the other. The males only produce this sound. The wings are nearly alike, and the right one is generally, but not always, uppermost. The veins are much contorted so as to produce a more or less drum-like space in the wing. One vein is file-like on the under side, and this plays like a bow on a raised part of the margin of the drum and causes the well-known sound (1209, 1213). In the male *Harpinus* flight is sacrificed to this power of producing sound, the hind wings are absent, and the front pair are converted into a drum.

Fig. 20.

Cylindrodes Kochii.

Most of the species burrow in the ground, or live under stones or in caves. *Nemeobius sylvestris*, found in the New Forest and in woods, lives among dead leaves. The Mole-cricket (*Gryllotalpa*, 1201) has the front legs specially adapted for burrowing. The tibia, which is very short, has prong-like projections below, the spurs are long, and the first and second joints of the tarsi are produced at the lower angle and thus form part of the burrowing apparatus. *Cylindrodes* (fig. 20) has a somewhat similar apparatus, but it is formed in a totally different manner. The prong-like projections are part of the *upper* edge of the tibia; the spurs are absent; and the tarsus, which is simple and too delicate to assist in burrowing, lies back on the inner side of the tibia, where it is protected.

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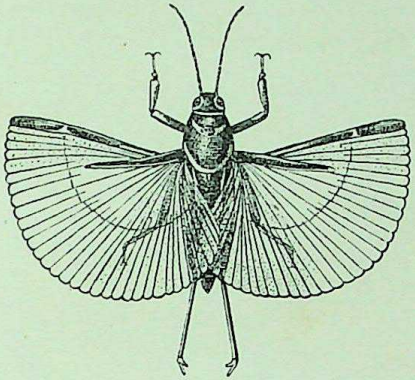
Species of *Gryllotalpa* are found in Europe (including England), Asia, Africa and Australia. *Cylindrodes* is found in Australia, and is said to live in the stems of a plant. It is quite smooth and of a yellowish colour.

A remarkable insect of this family is *Tridactyla*, a genus found in Europe, India, Africa and America. The hind tarsus is absent, and in its place are four curiously-formed spurs, which are hooked

Fig. 21.



Rhipipteryx limbatus, enlarged three times. (1203.)

and toothed at the end; one of these is directed upwards and inwards. A closely allied insect is *Rhipipteryx* (fig. 21, 1203). This has only ten joints to the antennæ, which in the *Gryllidæ* are usually very long and slender, and the wings are unlike those of any other insect. The front margin is leathery; the rest of the wing is fan-like, entirely without cross nervures, and when at rest is folded under the leathery front margin.

Family PHASGONURIDÆ.

The Long-horned Grasshoppers, *Phasgonuridæ* (1241–1254), differ from the *Gryllidæ* in having four joints to their tarsi. The first three joints are of about equal length, furnished beneath with soft fleshy pads which enable them to hold on to leaves and stems of plants. The antennæ are of great length and very slender, consisting of a large number of joints; 480 have been counted in the antennæ of *Meroncidius*. Table-case 34.

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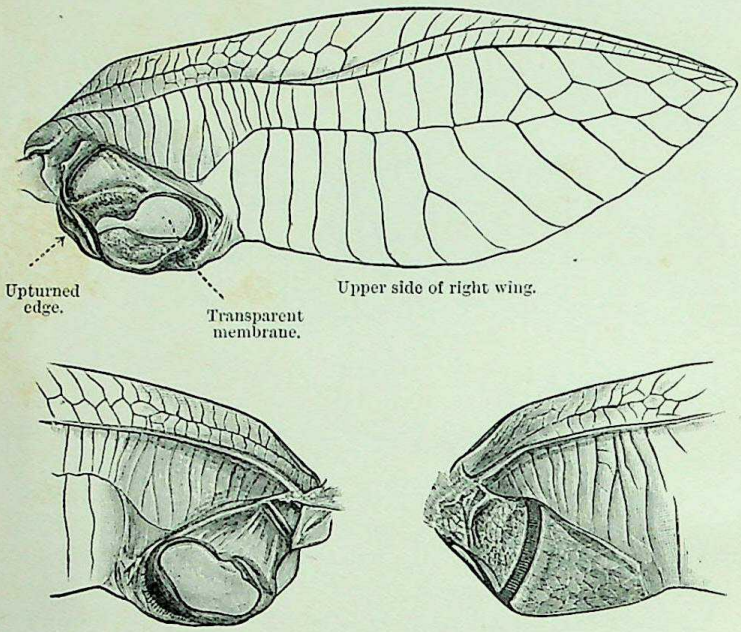
Table-case 34.

They live on trees and shrubs, feeding on leaves, but many species eat caterpillars, etc. The wings of many species in their form and coloration closely resemble dead or living leaves. Species of *Pterochroa* (1252) have the front wing leaf-shaped, marked with blotches as if injured by insects or fungi, and the edge has the appearance of having been eaten by a caterpillar. Some allied

Fig. 22.



Wings of a Long-horned Grasshopper (*Macrolyristes imperator*), slightly less than natural size.

genera (*Mimetica*, etc.) closely resemble dead leaves. Many kinds are wingless, such as *Hetrodes* (1245), and many others that live in caves. The males of some of these (*Anastostoma* and *Mimnermus*, for example) have very large heads, and have the jaws greatly developed. These are probably used for fighting. The males of *Gryllacris* (1244), allied winged insects, fight each other furiously, their wings being extended and held erect while doing so.

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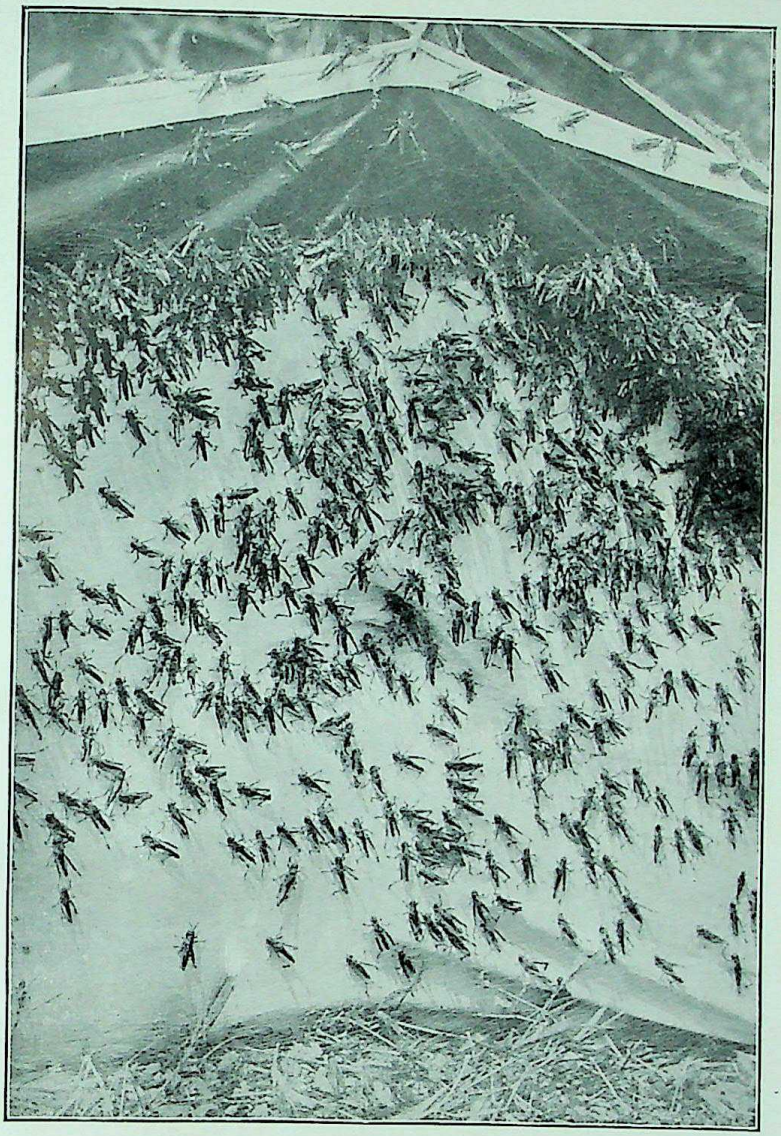
Fig. 24.



PHOTOGRAPH OF A SMALL PORTION OF A SWARM OF LOCUSTS. (*Acridium peregrinum.*) SHOWING A METHOD OF TRAPPING THEM. $\frac{1}{14}$ NAT. SIZE.

[*To face p.* 24.

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The males of the majority of the winged species produce a chirping sound. This is produced in the same way as in the Crickets, but the drum is at the base of the wing, and is more developed in the right wing; the left wing bears the file or bow and is always uppermost (fig. 22). In *Ephippiger* and a few allied genera both sexes are provided with a sound-producing apparatus.

A large number of species in this family have an auditory apparatus or ear at the base of the front tibiæ. The tibia at this point is somewhat enlarged, and on each side there is an oval impression, of a complex structure formed to receive sounds. In some species there is only a narrow slit instead of the oval impression. Both sexes possess this apparatus.

A curious Indian insect (*Schizodactylus monstrosus*, 1243), exhibited in this case, deserves special notice. It is remarkable for the great length of the wings, which, when at rest, are coiled at the tip like a watch-spring. The tarsi are also unlike those of any other insect. They have four joints, the first and fourth long, the second and third very short, and have on each side a broad and flattened lobe, in addition to which in the posterior pair the basal joint is expanded on each side into a triangular plate. This insect burrows to a considerable depth in the banks of rivers, remaining under ground during the day and flying by night. Some authors have placed this insect in the family *Gryllidæ* on account of its general form and burrowing habits, and on account of the absence of the ear-like impression on the front tibiæ. The tarsi are, however, four-jointed as in the *Phasgonuridæ*.

Family Locustidæ.

The next case contains the Short-horned Grasshoppers and Locusts, *Locustidæ* (*Acridiidæ* of many authors, 1271–1295). These differ from the five preceding families in having short antennæ. The tarsi have three joints, the basal ones being provided with soft pads beneath. A few species are wingless, or nearly so. In the species which have the wings fully developed, the front pair are of a firmer texture than the hind pair and serve as coverings for them; they are generally longer than the posterior pair. Table-case 34.

The front legs are not provided with an ear as in the *Phasgonuridæ*, but a somewhat similar organ is found on each side of the base of the abdomen. The chirping of grasshoppers is not produced by the wings, but by rubbing the femur against the wing. If the hind

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Table-case 34.

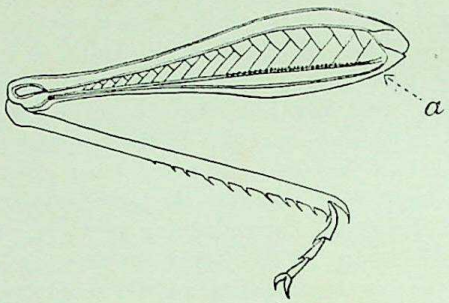
leg of a common grasshopper, *Stenobothrus bicolor*, for example, be examined with a magnifying glass there will be seen on the inner side of the femur a row of tubercles (or modified hairs). These rub against a prominent vein on the wing and produce a shrill sound.

So far as is known the large locusts do not produce this sound.

The eggs are long and narrow, elliptical. They are laid in batches in the ground (1280, 1293).

Some species are remarkable for the great development of the prothorax, which in some cases covers the whole body. It is sometimes arched and crest-like as in *Choriphyllum* and *Hymenotes* (1271).

Fig. 23.



Hind leg of a grasshopper (*Stenobothrus bicolor*).
a, row of tubercles.

Tettix (1272) and its allies have it prolonged backwards, the tip of the prolongation in some species projecting beyond the end of the body.

In many genera the forehead is more or less produced and sometimes pointed. This is very noticeable in *Tryxalis* (1275), a genus which has curiously flattened antennæ. *Proscopia* (1274), a remarkable wingless insect, not only has the forehead produced, but the whole of the upper part of the head is raised, the eyes being elevated with it.

To this family belong the true locusts, some of which, *Tropidacris* (1290) for example, measure nine inches in the expanse of the wings. The chief migratory species are *Pachytylus cinerascens* (1283), *P. migratorius* (1282), *P. migratoroides* (1284), *P. marmoratus*, *Acridium peregrinum* (1291), and in North America *Caloptenus srpetus*.

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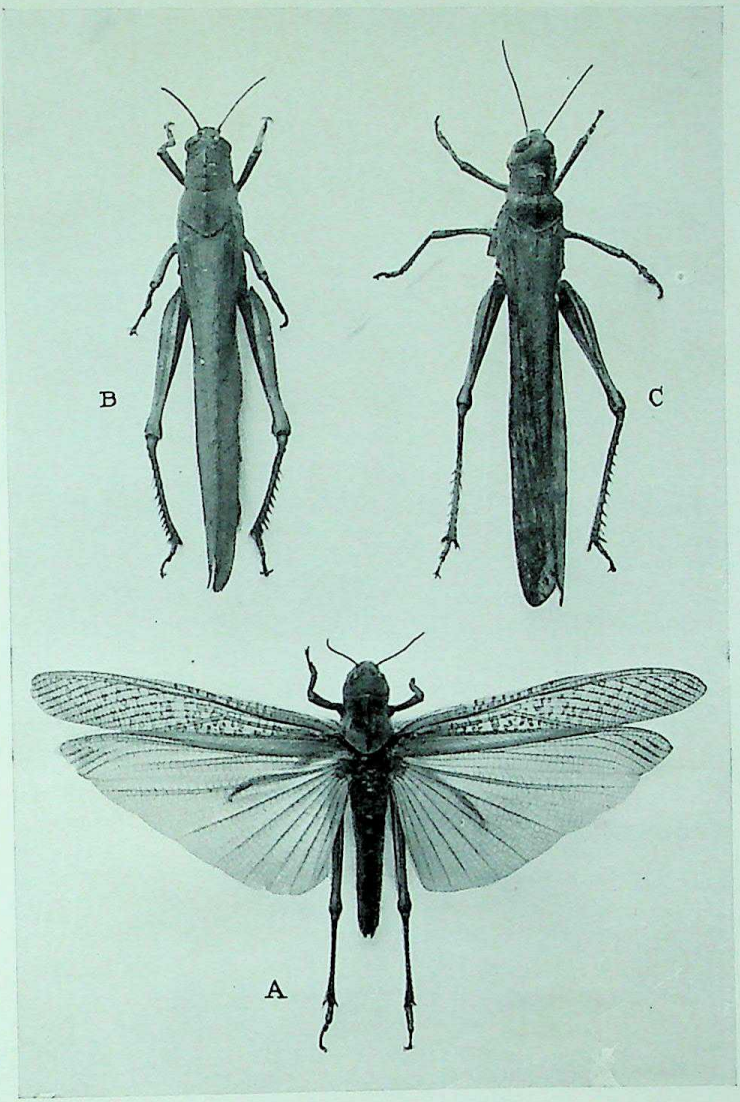
Fig. 25.



MIGRATORY LOCUSTS.

A. *Pachytylus migratorius.* B. *Acridium ægyptium.* C. *Acridium peregrinum.*

(All slightly reduced.)

(Photographed from specimens in the Museum.)

[*To face p.* 26.

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The extent to which these species are migratory and the height at which they fly vary according to the species and circumstances. *Acridium peregrinum* travels for some hundreds of miles; and swarms, probably of this species, have been met with a thousand miles out at sea. Their breeding places are generally dry and rather elevated plains. Their eggs are laid in the ground, in cylindrical masses, coated with earth. The swarms are often followed by birds, which devour large numbers of them. The grubs of flies of the genus *Bombilius* (or its allies), and those of certain Blister-beetles live on their eggs.

Some photographs are exhibited taken of a swarm of *Acridium peregrinum* which occurred in Algeria, showing the methods taken for entrapping them (fig. 24). The foreground of one of these shows the remains of what was a cornfield. The barrier is made of canvas, with a strip of American leather at the top, which being smooth does not give the locusts a good footing. At intervals the men shake the locusts off, and they are buried in trenches.

The species which are occasionally found in Britain are *Pachytylus migratorius*, *P. cinerascens* and *Acridium peregrinum*. *Acridium ægyptium* (1293) has since 1898 been frequently found in and around London, having been imported in vegetables (fig. 25B).

Order NEUROPTERA.

Sub-order ISOPTERA.

This case contains the commencement of the Neuropterous series, the *Isoptera*, White-ants or Termites (1300–1310). The metamorphosis is gradual, incomplete. In some individuals there is merely a difference in size between the young and the adult. The wings, when present, are four, folded flat on the back when at rest; the front and hind pairs are very similar in size and neuration, which is of very simple character; the distribution of the veins is, however, strangely dissimilar in different genera. Near the base of each wing there is a cross line where the wings are easily broken off, the basal parts remaining as horny flaps on the insect's back (fig. 26). The tarsi have four joints. Table-case 35.

The forms usually met with in a "Termitarium," *i.e.* a community of Termites, are soldiers and workers without wings in all their stages; and special sexual forms which have wings when adult.

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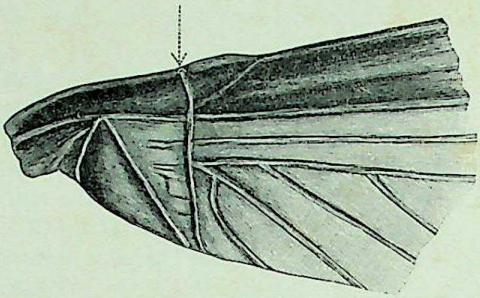
Table-case 35.

These forms are undistinguishable when they first leave the eggs, but soon show more or less of the character of the form which they will ultimately become. It seems, however, that Termites have some power of modifying or checking the development of individuals so that some females of the special sexual forms do not develop wings, and are held in reserve in case any accident should happen to

Fig. 26.



Base of a Termite's wing showing the line where the wing breaks off.

the "Queen" upon which the existence of the community depends. These individuals have been called "complementary reserve queens," and when actually substituted for a queen "substitution queens."

The special sexual forms above alluded to are so called because it is upon these that the continuance of the species appears to depend. Individuals of both sexes are found among soldiers and workers, but it is highly improbable that they ever reproduce their species. The males and females that have wings throw them off soon after leaving the nest in which they have been reared, and in some cases become kings and queens of new colonies. But from the enormous size to which some of their nests grow it seems probable that these kings and queens may continue with the original colony.

Wall-cases 9 & 10.

In their mode of life they much resemble the true ants, which are Hymenoptera. They live in large colonies. Their nests are very various in form. Some species (*Eutermes*, for example, 173) build nests in trees, but in this case it seems probable that the nest is connected by covered ways with an underground nest. Other species which have their nests underground build mounds above the ground, sometimes of curious shapes, the very large ones being three to ten feet or more in height (fig. 28). The greater part of the nest

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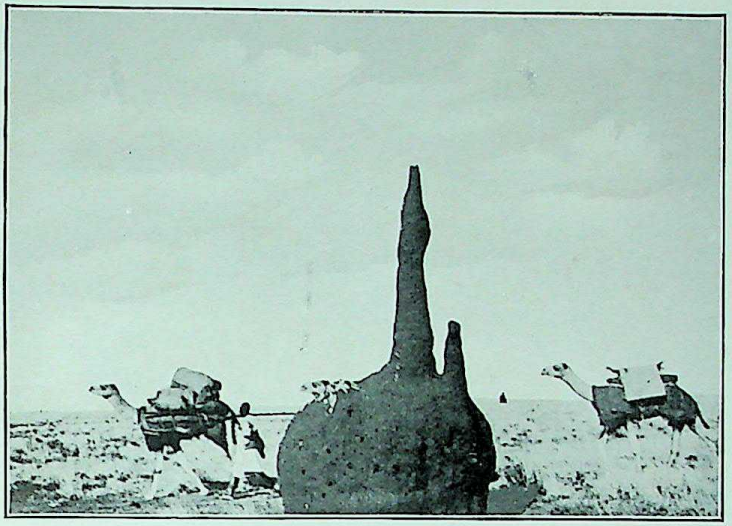
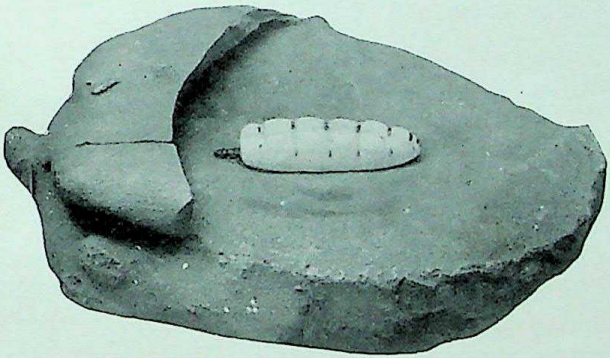
Fig. 28.



PHOTOGRAPH OF A WHITE-ANT'S NEST TAKEN IN SOMALILAND BY MR. F. GILLETT.

Fig. 29.



QUEEN'S CELL OF *Termes bellicosus* (203). ⅓ NAT. SIZE.
(Photographed from a specimen in the Museum.)

[*To face p.* 28.

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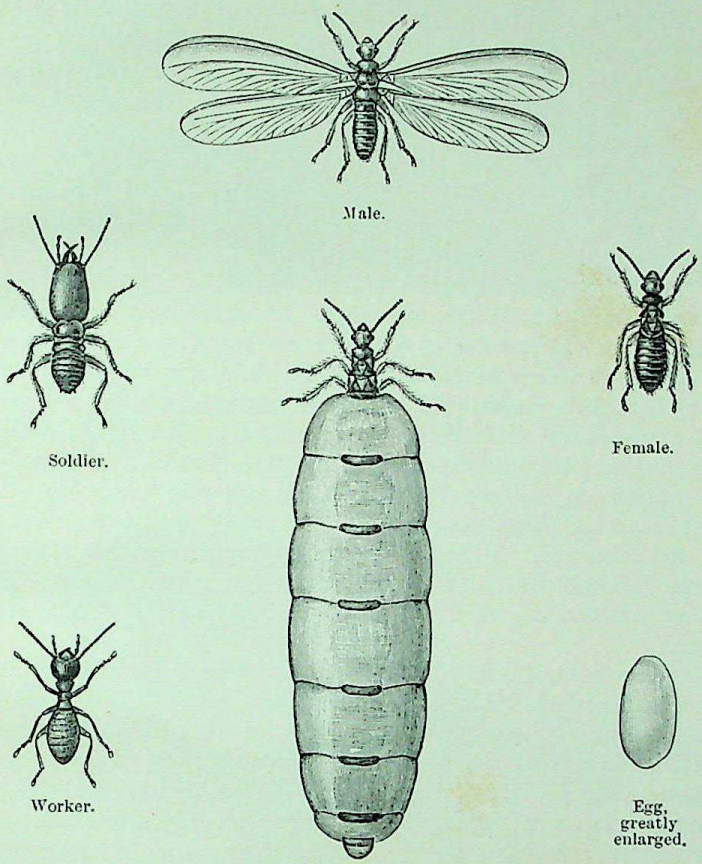
consists of cells, connected by galleries. Portions of these nests are exhibited in the wall-cases, as well as photographs of the whole nests. One kind of nest met with in Australia, of a flat, wedge shape, is

Fig. 27.



Termes fatalis, all enlarged. (1307.)

remarkable for the fact that its broad, flat surfaces always face nearly east and west.

A large photograph showing some of these nests is suspended on the wall. A nest met with in Sierra Leone has the upper part

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Wall-case 9.

built in three or four storeys (177). Examples are exhibited in Wall-case 9 (fig. 30).

In the underground nests the queens live in specially constructed cells, which are often of considerable size (203, fig. 30). Occasionally two queens are found in the same cell (193).

Some good examples are exhibited both in the table-case and in the wall-case. The queen when once established in this cell never leaves it. She is supplied with food by the workers, and the eggs as soon as laid are carried away to other parts of the nest through small holes in the sides of the cell.

The duty of the soldiers is to guard the nest, and for this purpose they are provided with very large heads, which are sometimes armed with a strong spine or spike. Others have large powerful jaws.

Some excellent examples of the destruction caused by these insects are shown in the wall-cases. Attention may be specially directed to the remains of a square lintel of a door of one of the Government offices in James Town, St. Helena, in which only the very hard parts remain (175). Another very good example is a piece of a greenhouse from Singapore presented by Mr. H. N. Ridley, showing very deep excavations (159, fig. 31). Most of the destruction is carried on secretly, the ants rarely showing themselves, the outside of the object attacked being left intact, so that the mischief is not observed. A small insect box brought to this Museum from Trinidad was found to have the lid completely hollow (163). Some live termites were still in it. This is exhibited in the wall-case.

The wings and remains of Termites have been found in abundance in a fossil state in Mesozoic strata in Europe.

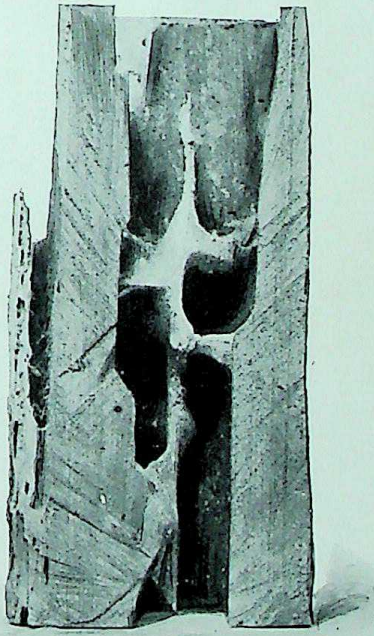
Table-case 35.

Immediately after the Termites are some examples of the very peculiar insects of the family *Embiidæ* (1318). These are closely allied to the *Termitidæ*, but have no soldiers or workers. Their metamorphoses are incomplete, the fully adult only differs from the young in size, and in some instances in having wings. Some species never have wings. They are in many respects very primitive insects, having the front and hind wings similar in size, form and neuration; the last being of a very simple character with few cross nervures. As the mesothorax is very long, the front and hind wings are remarkably far apart. The front and middle legs are wide apart at their bases and are placed at the side of the body as in the *Phasmidæ;* but the hind legs are closer together.

Fig. 30.

WHITE-ANT'S NEST FROM SIERRA LEONE (177).
$\frac{1}{3}$ NAT. SIZE.
(Photographed from a specimen in the Museum.)

Fig. 31.



WOOD EXCAVATED BY WHITE ANTS, SINGAPORE (159).
$\frac{1}{4}$ NAT. SIZE.
(Photographed from specimen in the Museum.)

[*To face p.* 30.

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The tarsi have three joints and the front ones are of very singular form.

The species are sometimes met with singly, but they are often social in their habits, and have been found congregated in a mass of webs, an example of which is exhibited (1311).

They occur in S. Europe, Asia, Africa and America.

Sub-Order Corrodentia.

These are small soft-bodied insects with incomplete metamorphoses. The head is free, generally rather large, wide, with prominent eyes. The mouth is provided with mandibles. The antennæ are long, composed of about a dozen joints. The prothorax, mesothorax and metathorax are nearly equal, the prothorax not very large. The wings are four, with a few branching veins which take curious curves, the hind pair smaller than the front pair. The front pair are held roof-like when at rest, the hind pair slightly folded at the base. The tarsi have two or three joints. Table-case 35.

Some species never have wings.

These insects are very common on trunks and branches of trees. Many kinds prefer dead wood.

One kind, *Atropos divinatoria* (1316), is very common in houses, especially if damp. It is sometimes destructive to collections of plants or insects. It is one of the insects called Death-watches. It makes a regular tapping noise, probably by striking its jaws against the wood it is resting on, the sound much resembling the ticking of a watch. It can only be heard in a quiet room where there is no noise.

Sub-order Plecoptera.

The *Perlidæ* or Stoneflies (1320–1325) are insects of moderate size, with incomplete metamorphoses. The head is slightly imbedded in the prothorax, with long, slender antennæ composed of very numerous joints. The hind wings are larger than the front ones, held horizontally over the back when at rest, with the inner portion of the hind pair folded. The tarsi have three joints. The larvæ live in water, feeding on decayed vegetable matter, but some are carnivorous. When fully grown they crawl out of the water, the skin splits down the back, and the perfect insect emerges. The adults frequent trees and are very active.

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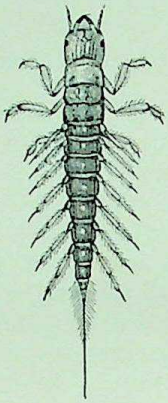
Sub-order SIALIDA.

Table-case 35.

The *Sialidæ* or Alder-flies (1327–1334) have the head imbedded in the prothorax. The antennæ are long and slender, composed of

Fig. 32.



Larva of Alder-fly (*Sialis lutaria*).
Enlarged.

numerous joints. The prothorax is rather large. The front and hind wings are of different shape, held roof-like when at rest, the hind ones ample and folded when not in use. The tarsi have five joints.

Their metamorphoses are complete. The eggs of the common British Alder-fly, *Sialis lutaria*, are laid on blades of grass, etc., generally near water. The larva (fig. 32) as soon as it leaves the egg makes its way to the water, where it spends most of its time in the mud, feeding chiefly on other small aquatic larvæ. The abdomen is furnished with tracheal gills. When fully grown the larva leaves the water and buries itself in the earth, where it turns to a pupa.

Sub-order PLANIPENNIA.

Table-case 36.

The next principal division of this order comprises the *Planipennia*, Snake-flies, Ant-lions, etc. These all have the head free (except the *Rhaphidiidæ*). The thorax is generally compact with the prothorax small; but in the *Rhaphidiidæ*, *Mantispidæ* and *Nymphidæ*, the thoracic segments are more or less distinctly separated, and the prothorax is larger. The four wings are nearly or quite similar in form and size (except in the *Nemopteridæ*), held

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roof-like when at rest, the hind pair never folded. The tarsi have five joints. The metamorphoses are complete.

They are divided into eleven families.

The first family contains the Scorpion-flies, *Panorpidæ* (1335), so called from the curiously developed apex to the abdomen of the males. They have the head prolonged downwards so as to form a beak. The antennæ are slender, composed of numerous joints. The wings are rather narrow, with numerous cross nervures. Table-case 35.

The larvæ feed in rotten wood.

The British species are common in woods. One curious genus, *Boreus* (1346), which is British, is wingless and lives in moss, and when walking much resembles a large flea.

The *Rhaphidiidæ* (1347) are insects of rather small size, remarkable for the length of the head and prothorax, whence their popular name Snake-flies. The antennæ are slender and composed of many joints. The four wings are equal and nearly similar, with a glassy appearance, and the veins form a network. The larvæ are very active, carnivorous, living chiefly under loose bark of trees and logs.

The *Mantispidæ* (1348) are at once recognised by the remarkable form of the front legs, which resemble those of a *Mantis*, formed for seizing small insects. The head is free, transverse, with rather large eyes. The antennæ are not very long, composed of many joints. The four wings are alike, equal, or with the hinder pair slightly smaller, the neuration forming a delicate network.

They are very numerous in tropical countries, and one is found in S. Europe. There is no British representative.

The eggs have a threadlike attachment as in the Lacewing flies. The young larva is very active. It attaches itself to the egg-sack of spiders, which it enters and later on feeds on the young spiders. It then changes its skin, completely alters its appearance, and is no longer active. It changes to the pupa within the larval skin.

The *Nemopteridæ* are easily known by the great length of the hind wings, which are very narrow, but sometimes dilated at the tips. One of the longest is *Halter imperatrix* (1353) from West Africa (fig. 33). Another remarkable form is one recently discovered in Asia Minor, *Chasmaloptera Sheppardi* (1357). Species of the genus *Croce* have the hind wings almost thread-like.

The neuration approaches that of the *Ascalaphidæ*, the fourth vein commencing about the middle of the wing.

The head is transverse with rather prominent eyes. The antennæ long or moderately long, slender.

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Table-case 36.

The species at present known are chiefly South European, African and Australian. A larva believed to be that of *Nemoptera* is found in the tombs in Egypt. It is remarkable for the great length of its neck (1354).

The *Nymphidæ* (1361) have the head free, transverse, with prominent eyes. The antennæ are moderately long and slender. The four wings are equal and similar. They show a typical neuration, the eleven veins being all distinguishable, with the fourth and sixth both complete to the base, and the seventh emitting a branch from about the middle. The tarsi have the claws furnished with membranous lobes.

These insects are Australian. Nothing is known of their habits.

The *Osmylidæ* (1362–1365).—The insects usually included in this family have the head variable, sometimes slightly imbedded in the prothorax, but generally nearly free, transverse, with rather prominent eyes. The antennæ are slender, of moderate length. The neuration of the wings is somewhat similar to that in the *Nymphidæ*, but the seventh vein is parallel to the sixth (and 6A), does not emit a distinct branch to the hind margin, and appears to terminate at a cross vein at some distance from the margin. Nearly the whole wing has a border of fine forked veins.

These delicate and beautiful insects are widely distributed. *Osmylus chrysops* (1362) is not uncommon in the New Forest. The larva is found under stones or in moss in or near water.

The genus *Dilar* is remarkable for the comb-like antennæ of the male. The genera *Ithone*, *Rapisma* and *Psychopsis* (1365) are included in this family, but they are very aberrant.

The *Hemerobiidæ* are rather small insects, with very short prothorax. The neuration of the wings is a still further departure from that seen in the *Nymphidæ*. The fourth vein is in part or wholly absent, and there are numerous veins branching directly from the third vein.

The larvæ are carnivorous and live chiefly on *Aphidæ* (Green-fly), from which they suck all moisture.

The *Chrysopidæ* closely resemble the *Osmylidæ*, but have the antennæ of great length. The neuration of the wings divides the surface into a number of oblique oblong cells; the fourth vein curves away from the third; the fifth is absent. There are often some curiously-formed cells at the base of the wing.

Their delicate gauzy wings have won for them the name of

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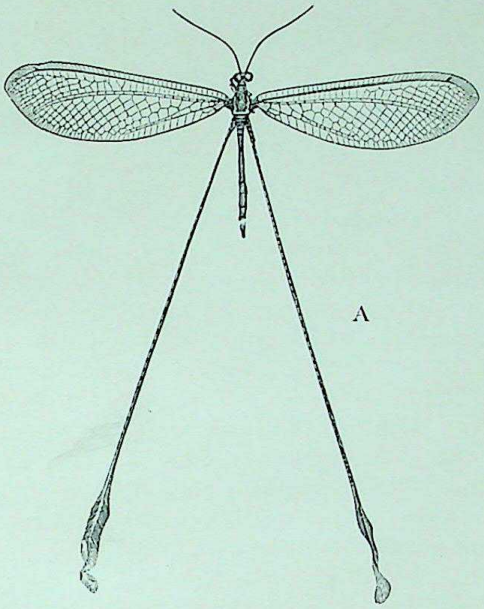
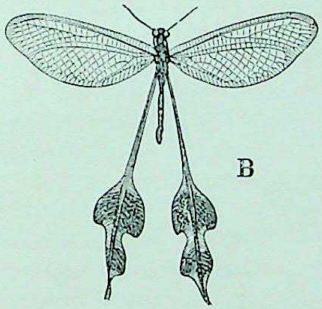
Fig. 33.





NEMOPTERIDÆ.

A. *Halter imperatrix* from W. AFRICA. B. *Chasmatoptera Sheppardi* FROM ASIA MINOR. SLIGHTLY REDUCED.

(Photographed from specimens in the Museum.)

[*To face p.* 34.

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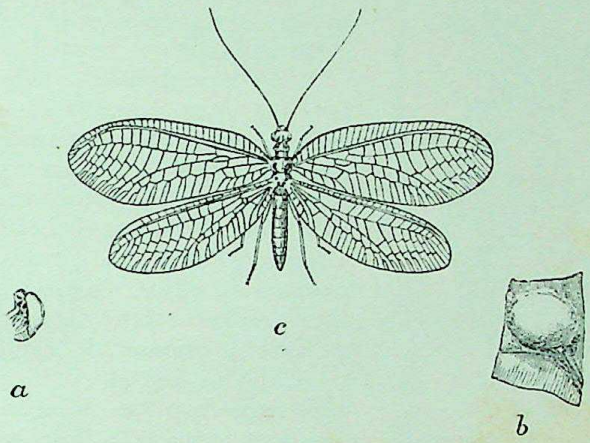
"Lacewings," whilst from their bright golden or coppery eyes they are often called "Golden-eyes." When handled they have a strong disagreeable smell. Table-case 36.

The eggs, which are laid in groups, are often found attached to leaves and other objects. They are white and are attached by long delicate threads.

The larvæ feed on *Aphidæ*, which they hold up in the air in their long jaws until all moisture is sucked out. Those of some species have the curious habit of placing the empty skins of their victims, as well as fragments of vegetable matter, on their backs so that they are often completely concealed. When walking they use the

Fig. 34.



a, Pupa; *b*, cocoon; and *c*, imago of Lacewing (*Chrysopa perla*), twice natural size. (1370.)

tip of the abdomen as a lever and a sucker, so that if they lose their hold of a leaf they can hang by the tip of the abdomen until they regain their footing. When full grown they spin a round silken cocoon in which they turn to the pupa.

The *Coniopterygidæ* (1372) are very small insects, having the body covered with a white powdery substance. The wings have a very simple neuration, with very few cross nervures. The hind pair are smaller than the front ones.

These insects resemble the *Chrysopidæ* in their habits and metamorphoses. Their larvæ have been found feeding on minute scale-insects and on *Aphidæ*.

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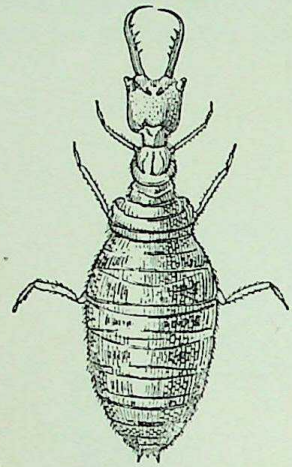
Table-case 36.

The *Ascalaphidæ* (1373–1382) are easily recognised by their long slender antennæ, which terminate in a spoon-shaped club. The head and thorax are generally hairy. There is considerable variation in the form and colour of the wings. The front ones are frequently angulated on the hind margin at the base, the angle in some cases forming a lobe. The cells at the tip of the wing are irregular and not very numerous. The fourth vein is joined by the fifth about the middle of the wing, and joins the third at some distance from the base. The legs are spiny and not very long; the claws long and gently curved.

Fig. 36.



Larva of a *Myrmeleon*. (1388.)

The larvæ closely resemble those of the *Myrmeleonidæ*, but have a series of tubercles at the sides of the body (1374).

The *Myrmeleonidæ* (1383–1385) have the wings generally of a more delicate texture than the *Ascalaphidæ*. The front and hind pairs are similar in shape and neuration, gradually narrowed to the base. The apex of the wing has a large number of fine veins radiating from the second and third veins. The antennæ are short, more or less thickened towards the tip (fig. 35).

The larvæ, fig. 36 (1388) are carnivorous. They live in circular pits excavated in the sand. These they make with their large flat heads, which they use as a shovel, jerking the sand to a considerable distance. When the pit is deep enough the larva rests concealed at the bottom with the jaws exposed ready to seize any ant or other insect that may fall into the pit. Their popular name of "Ant-lions" is due to this habit. They are found in Southern Europe and all tropical countries.

Sub-Order Agnatha.

The sub-Order *Agnatha* (1400–1409) consists of a single family (*Ephemeridæ*), popularly known as May-flies. They are very delicate insects with imperfectly-developed or no mouth parts. The antennæ are extremely short, and terminate in a bristle. The hind wings are much smaller than the front pair. The abdomen is furnished

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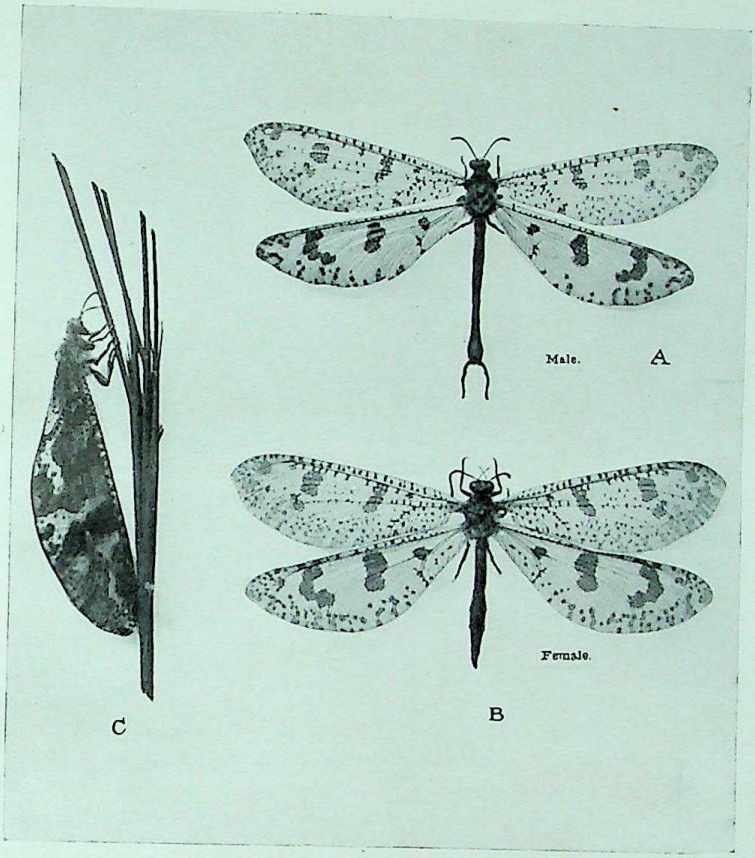
Fig. 35.



ANT-LIONS.

A. B. *Palpares libelluloides*, FROM S. EUROPE.

C. *Palpares cephalotes*, FROM ANGOLA (1383). ½ NAT. SIZE.

(Photographed from specimens in the Museum.)

[*To face p.* 36.

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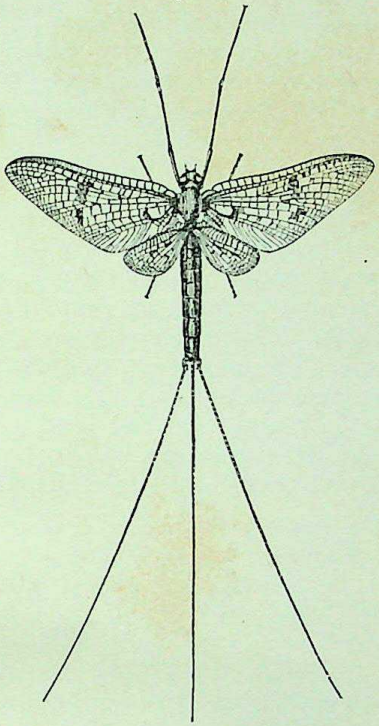
with two or three long, thread-like tails (fig. 37). When at rest the wings are held together erect, the abdomen slightly curves and the tails are directed upwards.

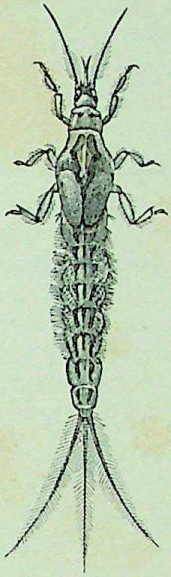
The early stages of these insects are passed in the water. The larvæ vary greatly in form according to their habits, and they are a considerable time arriving at maturity. In some cases this takes

Fig. 37.



May-fly (*Ephemera vulgata*), enlarged. (1400.)

Fig. 38.



Nymph of *Ephemera vulgata*. (1401.)

more than one year. The mouth parts are well developed, the mandibles in some cases being very large (1408). The abdomen is furnished with complex tracheal gills. There are sometimes leaf-like plates at the sides of the body (vibrated at frequent intervals in the water), sometimes they are tassel-like or feathery and are curved over the back. When the nymph (fig. 38) is full

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Table-case 36.

grown it makes its way to the surface of the water, the skin splits and the winged insect emerges. This process occupies a very short time, sometimes only a few seconds. This winged form, called the *sub-imago*, is, however, still enveloped in a delicate skin; this it throws off either immediately or soon, and the insect is then in its perfect state.

The food of the larvæ is chiefly vegetable matter, but some species are at least in part carnivorous.

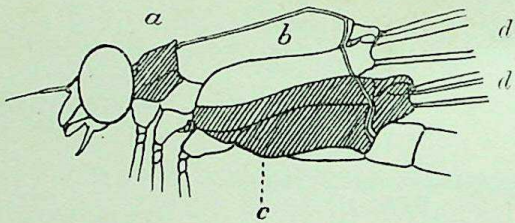
Some species of May-fly occur in swarms and appear in the air like a fall of snow. Specimens swept from a railway platform in Egypt after one of these swarms had occurred are exhibited (1409). A few of another swarm from Germany are in the same case in spirit (1403).

Sub-Order Odonata.

These insects, popularly called Dragon-flies (1410–1453), are insects with incomplete metamorphosis. The head is very large, concave behind, with very slender attachment to the thorax, so that it has complete freedom of action. The eyes are very large, sometimes touching each other above. The antennæ are very short and terminate in a bristle. The wings are equal or very nearly so. Although transparent they are somewhat hard and brittle. The veins form a network. The abdomen is very long.

One great peculiarity of this sub-Order is the form of the thorax.

Fig. 39.



Side view of the thorax of *Mecistogaster*.

a, prothorax; *b*, mesothorax; *c*, metathorax; *d*, *d*, bases of wings.

When viewed sideways the segments are seen to slant, so that the legs are in front of the wings (fig. 39). In other insects the base of the legs is under the base of the wings. The prothorax is very

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small. The mesothorax and metathorax about equal. The upper surface is not fixed as in other insects, but the parts are movable, which gives the wings great freedom.

In their early stages they live in water, and (like the adult) are carnivorous, feeding on other insects, snails, etc.

The larva possesses an extraordinarily developed labium. When at rest this is folded beneath the head, the front part of it forming a mask; but it is jointed and can be darted forward with great rapidity when the insect seizes its prey with the terminal toothed appendages (1410).

The Odonata have been arranged in two divisions :—

Div. I.—ANISOPTERA, in which the front and hind wings are more or less unlike, the hind pair enlarged near the base. This division contains the families *Libellulidæ*, *Corduliidæ*, *Gomphidæ*, *Cordulegastridæ* and *Æschnidæ*. The characters of these families are chiefly in the form of the head and the neuration of the wings as explained in the labels exhibited.

They fly with great rapidity.

Div. II.—ZYGOPTERA, in which the wings are alike, both pairs equally narrowed at the base. This division consists of two families, the *Calopterygidæ* (1439–1446) and *Agrionidæ* (1447–1453). Table-case 37.

Among these are some of the most brilliantly coloured insects known. Unlike the *Anisoptera* they are comparatively slow fliers, and are generally seen fluttering about the herbage at the sides of ponds.

Dragon-flies have been found plentifully in a fossil state in Tertiary strata, including species of *Libellula* and *Agrion*, both larvæ and perfect insects, differing but little from those of the present day. Some large species have also been found as far back as the Lower Lias.

The remains of an enormous insect, *Meganeura monyi*, measuring two feet in expanse of wings, have been found in the Carboniferous strata. It has four equal wings, and is evidently not far removed from the Dragon-flies. The neuration of the wings differs, however, in some important characters, and the shape of the body, so far as can be seen, is different. Its place appears to be between the May-flies and Dragon-flies. A drawing of one of the wings, natural size, is exhibited. There are no specimens in the Museum collection.

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Order TRICHOPTERA.

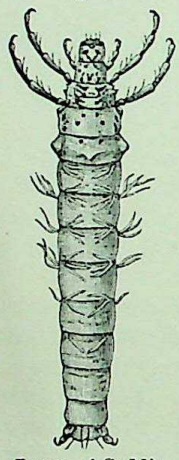
Table-case 37.

The second half of Table-case 37 contains the TRICHOPTERA or Caddis-flies.

These insects are sometimes regarded as a sub-order of the *Neuroptera*. They have the head free. The antennæ are nearly always long and thread-like, tapering to the apex. The mouth parts are small; the mandibles absent or very rudimentary; the maxillary palpi very variable, in some genera very large. The thorax is compact; the prothorax very small. The legs are long and slender with five-jointed tarsi. The front wings are more or less clothed with hair, slightly more leathery than the hind pair, held roof-like when at rest, the hind pair ample and pleated when at rest.

The larvæ live in ponds and streams; their food consists of vegetable matter. For the most part they live in cases which are built in various ways and of different materials, such as stones, sand, shells, bits of weed, &c. Some of these cases are coiled, and being built of fine sand have been mistaken for Mollusc shells (1478).

Fig. 40.



Larva of Caddis-fly.
Twice natural size.

The ordinary Caddis-fly larva (fig. 40) has the body soft, except the head and thorax that are exposed (1461). The first segment of the abdomen projects on each side, and has on the back a small tubercle which terminates in a sharp hook directed backwards. These projections secure the body in position in the case, whilst at the same time the water can pass freely through the tube; they also enable the larva to stretch itself out of the tube in search of food. Some of the segments are furnished with floating filaments that serve as gills. At the end of the body there are two strong hooks, which give the larva a firm grip on its case, and enable it to draw back rapidly into the case at the approach of danger. They turn to the pupa within the case, but when ready to turn to the perfect insect, they leave the case, swim to the surface of the water (using the middle legs, which are developed like oars for the purpose), the skin splits down the back and the fly emerges.

The perfect insects may be found on trees and herbage near water. Some of the very small species so closely resemble

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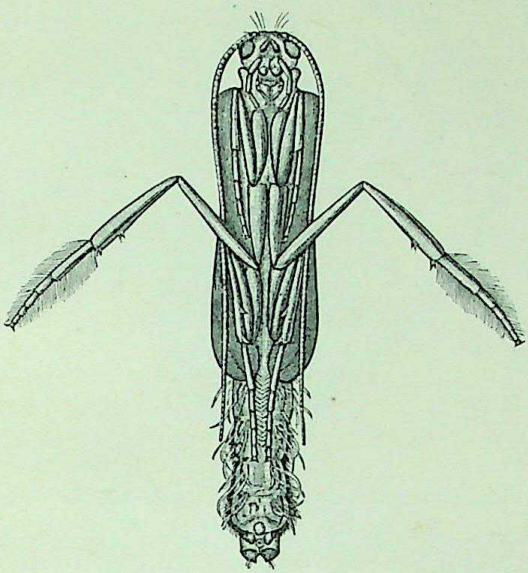
small moths that they require careful examination to distinguish them.

The principal families are *Phryganidæ*, *Limnophilidæ*, *Sericostematidæ*, *Leptoceridæ*, *Œstropsidæ*, *Hydropsychidæ*, *Rhyacophilidæ* and *Hydroptilidæ*.

Fig. 41.



Pupa of Caddis-fly in swimming position.
Twice natural size.

Order MALLOPHAGA.

The *Mallophaga* (1501–1508), commonly called Bird-lice, are small, wingless insects, with flat bodies, which undergo very little change in their growth to maturity. The head is large and free. The mouth is furnished with strong mandibles, lodged in a cavity beneath the head. The prothorax is distinct but not large. The mesothorax and metathorax are often only distinguishable from the abdomen by the legs being attached to them. The legs are attached to the sides of the segments. The tarsi have two (rarely three) joints, terminating in one or two claws.

The majority of the species live among the feathers of birds. A few are found on mammals.

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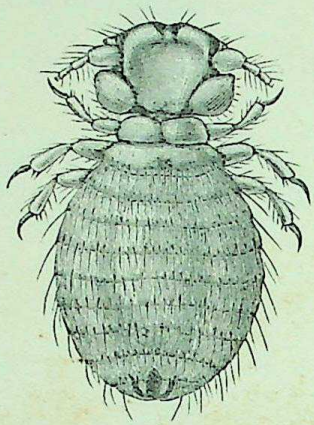
Table-case 37.

Drawings and specimens of *Trichodectes latus* (1501, fig. 42) found on dogs, *Menopon pallidum* found on fowls, and other species are exhibited.

Like most parasites they are difficult to locate satisfactorily in

Fig. 42.



Trichodectes latus, from dog; enlarged thirty-six times.

any natural system, but they appear to be most nearly allied to the *Orthoptera*.

Order LEPIDOPTERA.

Table-case 38.

At the sides of the gallery are cabinets of British Lepidoptera. Four on the west side contain the collection of caterpillars prepared and presented by the late Lord Walsingham. One on the east contains the collection formed by the late William Buckler, the author of "The Larvæ of the British Butterflies and Moths," published by the Ray Society. It was presented to the Museum by Robert Newbury, Esq.

The foreign Lepidoptera are in cabinets on the east side of the gallery.

The insects of this Order are popularly known as Butterflies and Moths.

They undergo a complete metamorphosis. The larva is popularly called a caterpillar; the pupa a chrysalis. The perfect insect has the head free. The thorax is compact; the prothorax very small; the mesothorax very large. The wings are very variable, clothed (as well as the body) with scales. The mouth parts (Fig. 43) are

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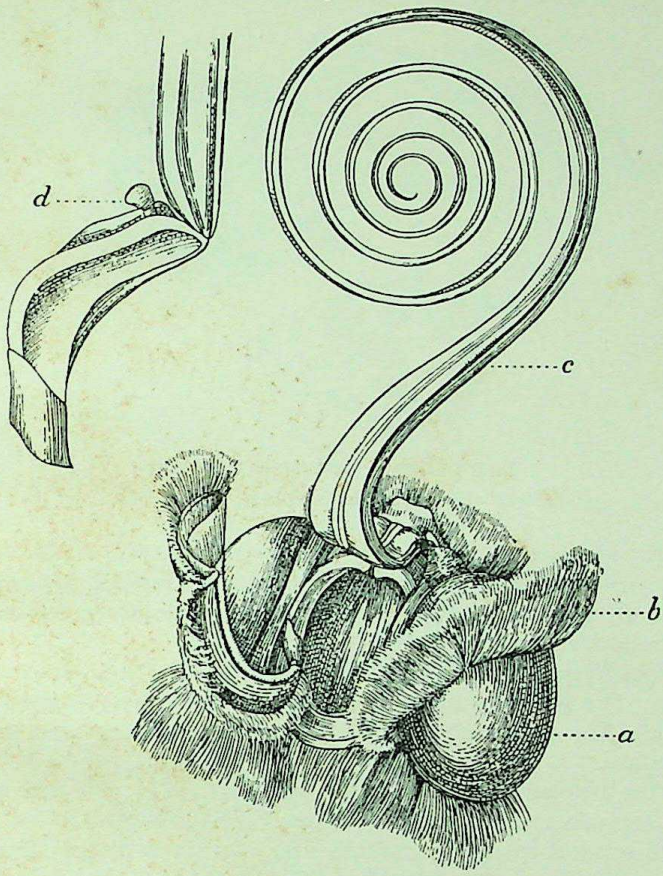
imperfectly developed, except the maxillæ, which (except in a few cases) are greatly prolonged and united by their edges to form a proboscis or tube (through which moisture can be drawn into the

Fig. 43.



Head of a Sphinx moth showing the parts of the mouth and proboscis. *a*, Eye; *b*, labial palpus; *c*, maxillæ; *d*, maxillary palpus on base of maxilla.

mouth), coiled like a watch-spring when at rest. The labial palpi are well developed, usually standing up in front of the head, sometimes of great length. The maxillary palpi are generally very small or absent, except in the most primitive family *Micropterygidæ*, where they are well developed.

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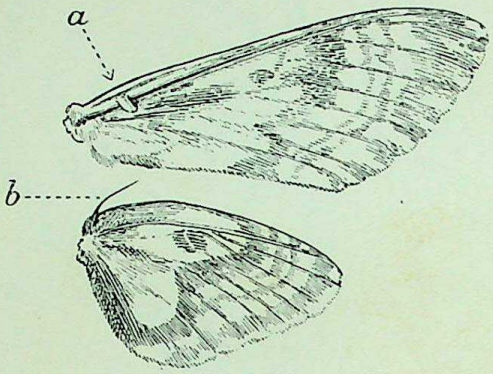
The *Lepidoptera* are usually divided into two great groups, LEPIDOPTERA HETEROCERA and LEPIDOPTERA RHOPALOCERA.

The *Heterocera* or Moths generally have the hind wing united to the front wing by a "frenulum," which hooks into a strap on the

Fig. 44.



Wings of Death's-head moth, under side.
a, Strap which holds the frenulum; *b*, frenulum.

under side near the base of the front wing (fig. 44). They have very various antennæ, generally long, slender and tapering to a point, often fringed and frequently comb-like. Comparatively few have them thickened towards the tip.

The *Rhopalocera* or Butterflies have the antennæ terminating in a club. This is very variable in shape and extent and is sometimes very slight. The hind wings are not united to the front ones by a frenulum.

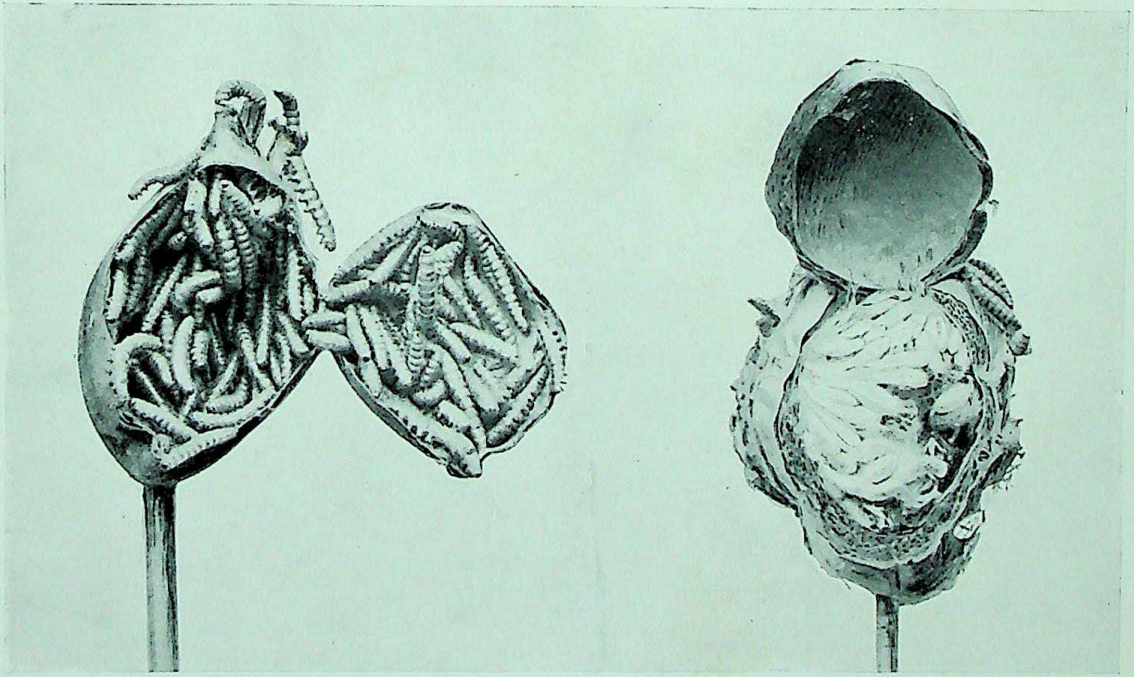
The *Heterocera* are divided into numerous families. The drawings and explanatory labels will be found in Table-cases 38–41.

A series of specimens illustrating the life-history of the different species of Silk-moths are exhibited in the Economic Series in the North Hall. The common Mulberry Silk-moth, *Bombyx mori*, has been cultivated for so many centuries that its origin is uncertain, but it is probably a native of China.

On a shelf on the east side of the gallery are models and drawings illustrating the habits of various species, many of them of interest on account of the injury they do to fruit trees, &c.

Wall-case 8. In Wall-case 8 on the west side of the gallery are some interesting

Fig. 45. Fig. 46.



COMPOUND COCOONS OF A MOTH (*Anaphe panda*) FROM S. AFRICA (263, 265). ¼ NAT. SIZE.

(Photographed from specimens in the Museum.)

[*To face p.* 44.

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compound cocoons of gregarious moths. Attention is particularly called to one of *Anaphe panda* from S. Africa (263) in which there is a crowd of caterpillars, and by its side a similar nest (265) in which the caterpillars have spun their cocoons (figs. 45, 46). When the moths come out they escape by the opening at the top. (Further particulars about this nest will be found in Table-case 40.)

In the same case is a somewhat similar nest from Madagascar formed by *Hipsoides bipars*. In this instance each moth escapes by an opening made by itself (269).

The *Rhopalocera* are divided into five principal families; the characters by which these may be recognised are explained by a series of labels, drawings and specimens set out in a tabular form in Table-case 42. Table-case 42

Order HYMENOPTERA.

Wall-cases 11–16, Table-cases 44–48.

The Saw-flies, Ichneumons, Ants, Wasps and Bees belong to this Order.

A small series of specimens will be found in drawers 1–8 of a cabinet on the west side of the gallery.

They have complete metamorphosis. The perfect insect has the head free, with slender attachment to the prothorax. The thorax is compact, the prothorax small, the mesothorax large. They have four wings with few veins; the hind pair united to the front pair by a series of hooks (except in some minute species). The basal segment of the abdomen is in varying degrees more closely united to the thorax than to the following segments, and in the majority the communication between the first and second segments is by a narrow neck or waist as in the hornet. The tarsi have five joints, except in some minute parasitic species.

They are classed in two great divisions :—

I. Hymenoptera Terebrantia, in which the legs have a double trochanter.

II. Hymenoptera Aculeata, in which the legs have a single trochanter.

These are further divided into fourteen principal families. The characters by which these may be recognised are explained by specimens, drawings and labels arranged in a tabular form in Table-case 44. Table-case 44.

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In the second half of the same case are some examples of Saw-flies. The metamorphosis of the common Currant Saw-fly is illustrated by a series of coloured drawings. Specimens of the fly with leaves injured by the larvæ are also shown. The eggs are laid in rows on the ribs on the under side of the leaves. Examples of another species, *Nematus propinquus*, the larvæ of which sometimes strip the leaves from Black Poplar, are also exhibited.

In the same case will be seen a female example of the Pine Borer, *Sirex gigas*, in the act of depositing eggs in wood. The larva burrows into the solid wood, and often does much damage in fir plantations.

Table-case 45.

In the next case are some examples of *Ichneumonidæ*. One of these, *Rhyssa persuasoria*, is a parasite on the larva of *Sirex*. In order to deposit its eggs on or near the larva of the *Sirex*, it is provided with a very long ovipositor, but how the insect passes this delicate instrument through solid wood is unknown. A small piece of wood with the ovipositor of a specimen in it is exhibited. Unfortunately the insect was broken when found. An allied species, *Rhyssa atrata*, with much longer ovipositor; is also shown.

Some examples of the white cocoons made by *Braconidæ* (often mistaken for spiders' nests) are shown in the same table-case ; and also a series of galls made by Gall-flies, *Cynipidæ*. An interesting series of the galls will also be found among the models on a shelf on the west side of the gallery.

Wall-case 11.

Wall-cases 11 to 16 are devoted to nests of ants, wasps, and bees.

Among the ant-nests should be noticed one made by binding together leaves with silk threads (317, 319). This is the work of a moderately large pale green ant, *Œcophylla smaragdina*, a common species in India, with varieties in Africa and Australia (fig. 47).

Several brown nests from trees are exhibited. These are built by species of *Crematogaster*, and from their form have been called "Negro Heads" (301–311).

A small nest of the Provident Ant (321), *Atta barbara*, now known as *Aphenogaster barbara*, which stores its nest with seeds, is shown in the same case. Another curious nest is that of *Polyrhachis bispinosus* (327) from Brazil. This is made of soft substance and has the appearance of a sponge.

Formica fuliginosa, a common English black ant, forms its nest in hollow trees. A portion of one of their nests is exhibited (335). Another complete nest (333), found near Guildford, was built in a house under the drawing-room floor.

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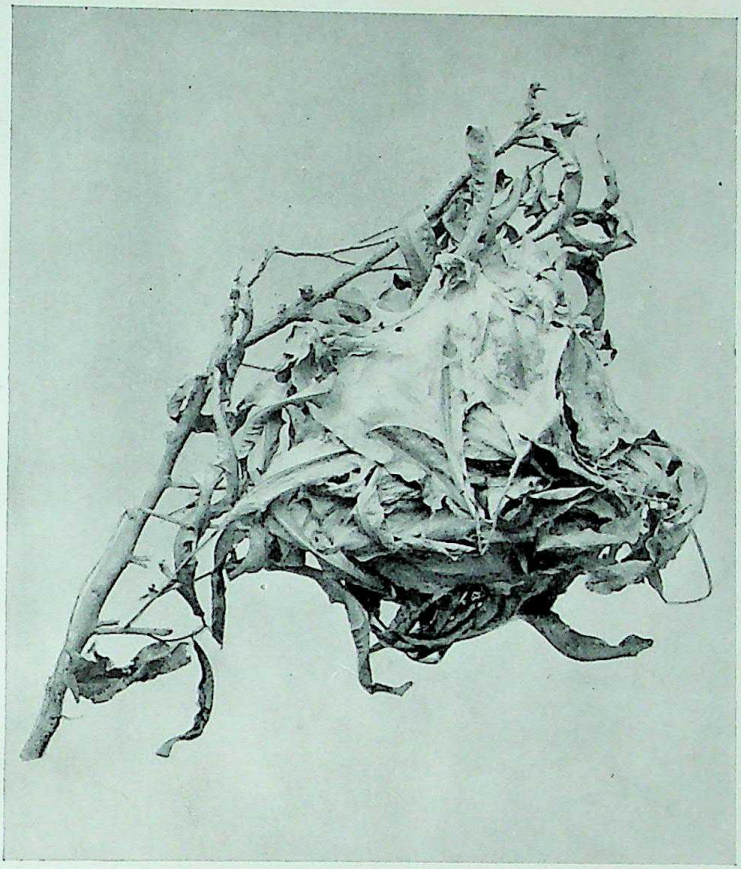
Fig. 47.



NEST OF AN ANT (*Œcophylla smaragdina*) FROM CALCUTTA, MADE BY BINDING LEAVES TOGETHER WITH SILK THREADS (327). ¼ NAT. SIZE.

(Photographed from a specimen in the Museum.)

[*To face p.* 46.

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A remarkable entrance to an ant's nest is shown at the bottom of the case (339, 340). This ant, *Phidole Sykesi*, forms its nest on the side of steep hills, and round the entrance there is a curious structure, consisting of concentric walls or ridges. The object of these walls appears to be to protect the entrance from the water that rushes down the hill during heavy rain.

Specimens of various ants will be found in drawer 5 of a cabinet on the west side of the gallery, and in Table-case 45. Among them examples of the Foraging ants of Central and South America, *Eciton omnivorum*, male and worker, and soldier and worker of *Eciton hamatum*. These ants travel in enormous numbers, sometimes in narrow lines, sometimes in broad columns. They kill and carry away with them cockroaches, beetles, and all kinds of insects, and even lizards. Table-case 45.

The Driver ants of Africa, *Dorylus*, are even more formidable, and when foraging will attack and destroy all kinds of insects, as well as large snakes, chickens, &c. Those that travel in this way are the workers. The males are large winged insects. The females are wingless and still larger, but are rarely found. There are three examples in the Museum which are believed to be the females of *Dorylus nigricans*, of which *Dorylus Burmeisteri* is believed to be the worker. The variation in the sizes of the individuals, and in the relative sizes of their heads, is very remarkable.

Specimens of *Œcophylla smaragdina*, female and worker, above referred to, and also workers of the "Leaf-carrying," or "Umbrella Ant," *Œcodoma cephalotes*, are in the same case.

Some eggs of an ant, *Myrmica*, are also exhibited. The "ant-eggs" sold as food for birds are not eggs, but the cocoons made by the larvæ of ants.

Wasps of the genus *Scolia* are parasitic upon the larvæ of beetles. A series of *Scolia flavifrons* is exhibited in Table-case 46. This species lives on the larva of a Rhinoceros beetle, *Oryctes nasicornis*. The female *Scolia* deposits an egg on the under side of the larva of the *Oryctes* after paralysing it with her sting. The larva of the *Scolia* does not eat the *Oryctes* larva, but gradually sucks it dry. Table-case 46.

The species of *Pepsis* and *Salius* are among the largest known wasps. A large *Pepsis* from Ecuador is exhibited.

The species of *Salius* store their nests with spiders. The large

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species attack and kill even the large Mygales. The *Salius* will hover round the nest of the Mygale and sometimes entice it out by touching the spider's web; it will then pounce on the spider and render it helpless by stinging it. Sometimes a struggle takes place, and the two will roll over and over, but the wasp is nearly always victorious. A specimen of *Salius dedjax* from German East Africa, with the Mygale which it had caught and was carrying away, are exhibited.

Wall-case 12, and Table-case 46.

In this case are exhibited a series of nests made by various wasps. Among these are numerous cells or nests built of mud by species of *Pelopœus*.

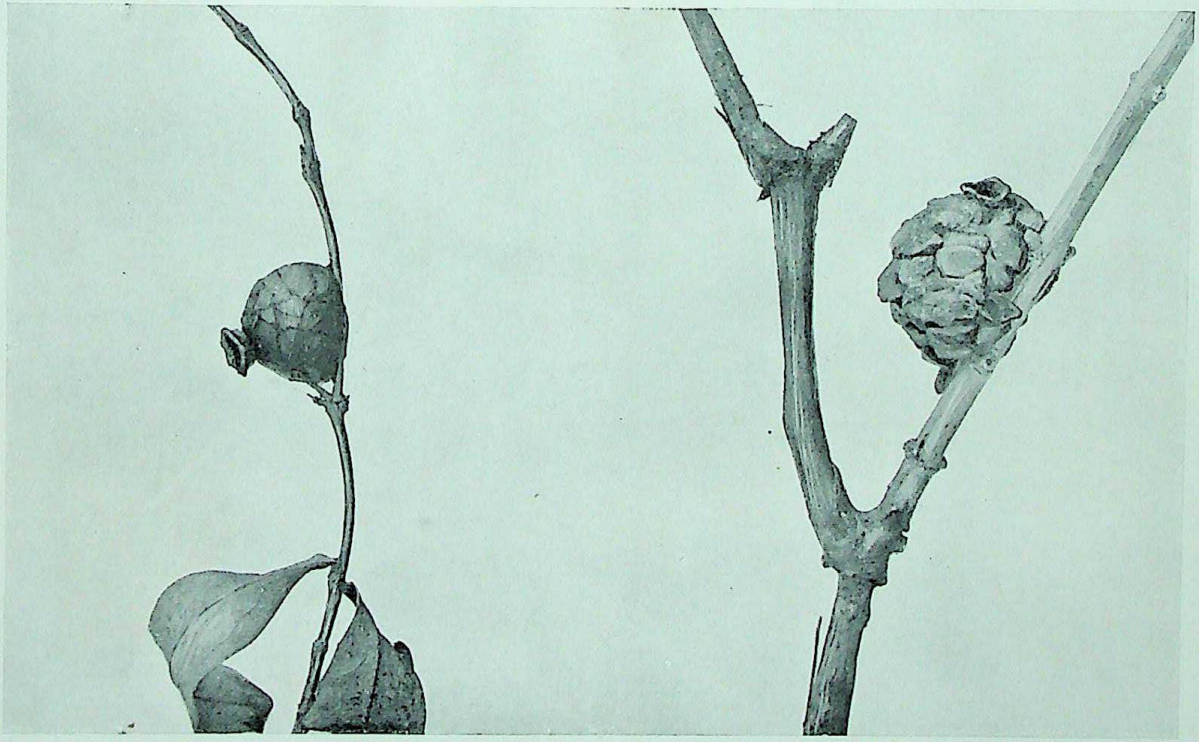
Pelopœus figulus (401) and *P. histrio* (403) form groups or masses of cells. Examples are exhibited in Wall-case 12 and in Table-case 51. These cells when completed are filled with insects, or more generally with spiders, to serve as food for the larvæ of the wasps. The remains of the spiders can be seen in the nest of *Pelopœus bilineatus* from N.W. India, exhibited in Table-case 46, and in the nest of *Pelopœus chalybeus* from Natal in the same case. The cells of this species are placed in pieces of bamboo. *Pelopœus lætus* from Australia (397), Wall-case 12, and *P. madraspatanus* from N.W. India, Table-case 46, sometimes build separate cells, but a curious group of cells formed by the latter species in a deserted bird's nest should be noticed in Wall-case 12 (391).

The species of *Crabro* form burrows in various places; some in the ground, others in decayed wood, in bramble stems, &c. The cells are stored with insects, most commonly perhaps with Diptera. An example of a piece of willow with cells of *Crabro cephalotes* from Barnes Common is shown in Table-case 46.

The species of *Odynerus* avail themselves of any suitable hole in which to make their mud nests. Two curious examples are exhibited in Wall-case 12, one built in the centre of a reel of cotton, the other in a blind-tassel (415).

Among other clay nests that specially deserve notice are some built by species of *Eumenes* in the shape of vases (449, fig. 48). Another standing with these, from Aden, and evidently formed by a member of this genus, is noteworthy for the size of the stones fixed on the outside (447). It is remarkable that such a small insect could carry and manipulate stones of this weight. The size of the insect can be judged by the hole through which it emerged from the nest (fig. 49).

Fig. 48. Fig. 49.



NESTS OF SPECIES OF *Eumenes* (447, 449). NAT. SIZE.

(Photographed from specimens in the Museum.)

[*To face p.* 48.

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Close by these are two nests built by a species of *Ischnogaster*. They were found attached to roots on an overhanging bank in Borneo by the late Mr. J. Whitehead (445). The form of the entrance with its open-work at the back should be noticed (fig. 50). Other somewhat similar nests from Ceylon, formed by another species, will be found in Table-case 46 (fig. 51). Table-case 46.

Some Social Wasps build their nests without covering, others are enclosed. Among those built without cover are those of *Polistes* and *Icaria*.

In the wall-case are examples of the flat nests built in trees by species of *Polistes* (341–355). It will be observed that these are suspended by a stalk from the centre of the nest (fig. 52). The species of *Icaria* build somewhat similar nests, but instead of making them circular they increase the size of the nest by adding cells at one end, the result being a long narrow nest. One from Singapore (359, fig. 53) about a foot long is in the wall-case, and some smaller ones will be found in Table-case 46.

This case contains nests formed by various species of *Vespa* (the common wasps and hornets). The nests built by some of the Indian species attain great size; one measuring thirty-two inches in length is suspended in the middle of the wall-case. Wall-case 13. Table-case 46.

The English Hornet, *Vespa crabro*, builds its nest chiefly of rotten wood, sometimes in hollow trees (499, 535), frequently in roofs of outhouses (489, 493). Those in hollows are generally without covering, but suspended nests have a thick outer case.

The other species of the genus *Vespa* are called Wasps, of which there are six British species.

The nest of *Vespa vulgaris* is somewhat similar to that of the Hornet, but is composed of much finer material. The patches on the cover are smaller, with concentric curves or wavy lines of different shades of buff and brown (of a lighter colour than in the Hornet's nest), giving the nest a very pretty appearance. This wasp prefers to build underground, but the nests are found not infrequently in roofs of outhouses (511, 515). A nest of this species was recently found in a hat which was hanging in an outhouse at Tring, and was presented to the Museum by the Hon. Walter Rothschild (507).

The nest of *Vespa germanica*, another common species, is generally underground. It is formed of vegetable fibre and is of a grey colour (465).

Vespa norwegica is a tree wasp. The nest is of a grey colour, with whitish marks and lines, built of vegetable fibre. The outer

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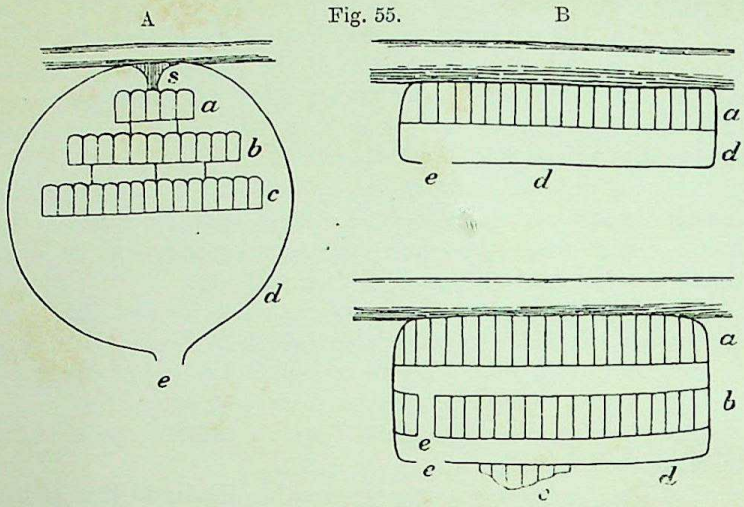
cover is very delicate, almost like tissue-paper (473, 475, 497). In their early stages these nests are pretty objects. Several are exhibited in Table-case 46, and one in a more advanced state will be found among the groups on the east side of the gallery (69).

Two examples of a very remarkable nest are to be seen in this case (501, 502). They are built entirely of clay, including the comb. They have been found in South America, hanging from branches, but no specimens of the insect have yet reached the Museum (fig. 54).

In the covered nests built by Social Wasps, two styles of building

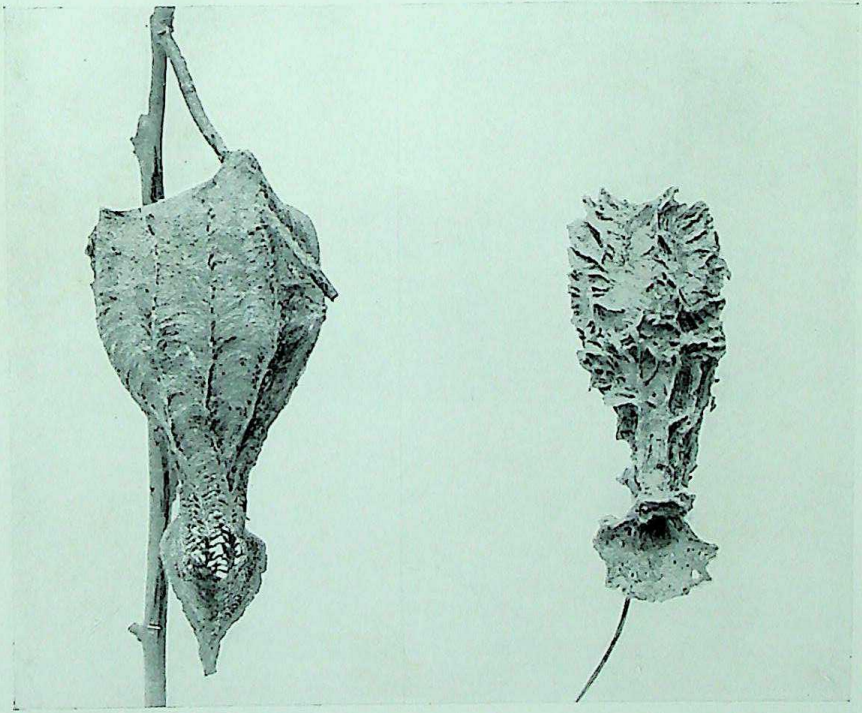


Diagrams of wasps' nests.

are noticeable. The common British wasps, *Vespa*, commence the nest with a stalk attached to some object (fig. 55, A, *s*, *a*), with a few cells suspended by it. Below this they suspend a second series of cells, *b*, hanging by stalks from the first series, then a third series, etc. The whole is surrounded by a cover or envelope, *d*, which has an opening below, *e*; this covering is enlarged as the combs are increased in number and size.

In the second style of nest (fig. 55 B) the cells are attached to some leaf or branch, without a stalk, and when a row of cells (*a*) is completed it is enclosed in a thin cover (*d*) with an opening below, generally at one side. The second row of cells is built on the outside of

Fig. 50. Fig. 51.



NESTS OF SPECIES OF *Ischnogaster*. NAT. SIZE.

(Photographed from specimens in the Museum.)

[*To face p.* 50.

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this (fig. 55 c), and when completed is covered in the same way, a passage (*e*) *through* the comb being left for access to the first row. A third row of cells (*c*) is then built in the same way. The Brazilian wasps of the genera *Polybia*, *Chartergus*, etc., build in this way, and numerous nests are exhibited. The covering of the nest of *Chartergus chartarius* is nearly white and smooth, and in this and in its texture exactly resembles card, whence it has been called "the Card-making Wasp." One very large example exhibited (573, fig. 56), from the river Amazon, presented by Mr. G. Brocklehurst, contains twenty-two rows or storeys.

Wall-case 15. Table-case 46.

In Wall-case 16 are various nests of bees. Species of the genus *Osmia* will make a nest in any place which appears to them suitable, garden locks being sometimes chosen. A pipe with cells of *Osmia rufa* is exhibited (647), and another still more curious example is a book with a series of cells (631). This book was in a book-case pressed against the back; this left just room for the bee to get behind it. It is from Hawkhurst, Kent, and was presented by Miss Evelyn Hardcastle. Another nest built between two flower-pot saucers is exhibited in Table-case 48.

Wall-case 16.

Three disused birds' nests which have been used by humble-bees to build nests in are exhibited (639, 643). One of these nests from East Clandon, Surrey (641), has been attacked by a moth (*Aphomia*), the caterpillars of which, having fed on the wax of which the bees' cells are made, have spun their cocoons on the top.

At the top of this case will be seen a single comb of great size formed by an Indian honey-bee, *Apis dorsata* (609). This honey-bee, unlike the common honey-bee, *Apis mellifica*, does not build in hollow trees, etc., but suspends the combs from the branches of trees without covering. An excellent photograph of a group of combs of this species is shown in Table-case 47, which is devoted to the explanation of the habits of honey-bees. Greatly enlarged drawings are exhibited to show the difference in the structure of the queen, drone and worker. The worker has the femora clothed with long barbed hairs (fig. 58 *a*); the tibia is concave on the outer side, the edges furnished with long-curved hairs, the whole thus making a sort of basket in which pollen is collected (*b*). The apex of the tibia is furnished with a series of teeth like a comb, with which the wax is removed from the abdomen (*c*). The under side of the first joint of the tarsus has rows of short stiff hairs, the whole forming a brush with which to collect the pollen and put it into the basket on the tibia (*d*). Other points of interest in connection with this bee are

Table-case 47.

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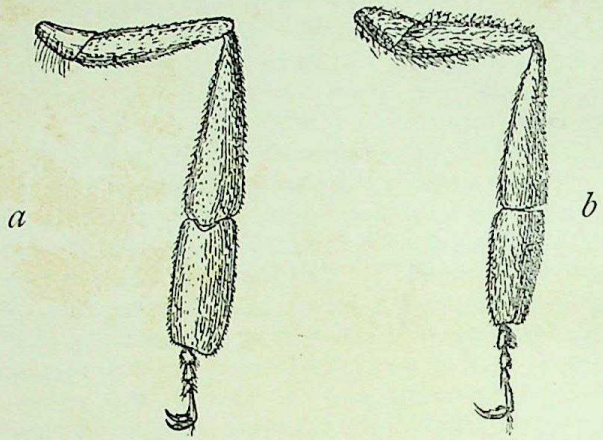
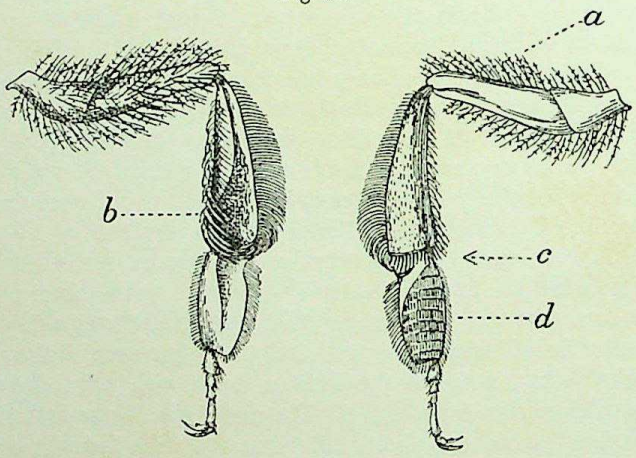
explained by drawings and specimens. The visitor should not fail to notice the flakes of wax removed from the abdomen of a specimen. It will be seen that these are nearly transparent, and it is only after

Fig. 57.



a, Hind leg of drone; *b*, hind leg of queen honey-bee.
(Enlarged 6 times.)

Fig. 58.



Upper and under sides of the hind leg of worker honey-bee.
(Enlarged 6 times.)

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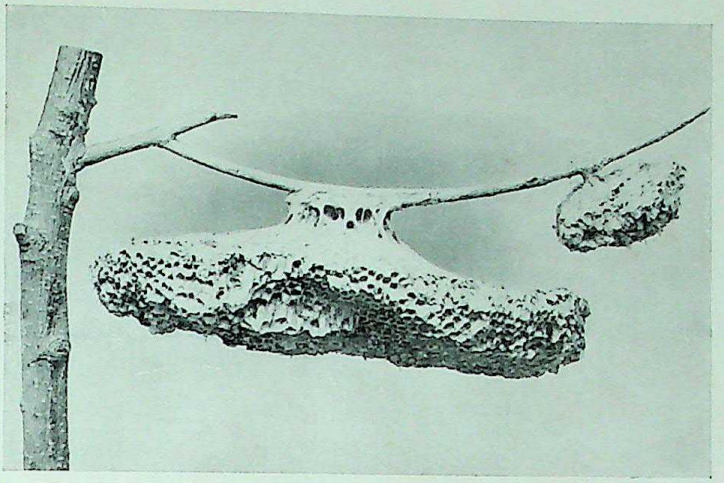
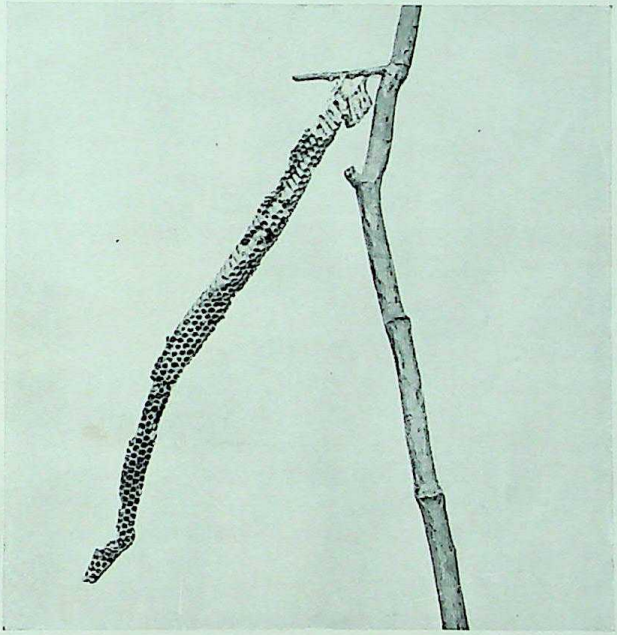
Fig. 52.



NEST OF *Polistes orientalis* (353). $\frac{1}{5}$ NAT. SIZE.

Fig. 53.



NEST OF A SPECIES OF *Icaria* (359). $\frac{1}{4}$ NAT. SIZE.

(Photographed from specimens in the Museum.)

[*To face p.* 52.

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being worked by the bee's mouth that they lose this transparency. Other bees are shown in Table-case 48.

Table-case 48.

Among the Carpenter-bees, *Coptorthosoma*, from Ceylon, should be noticed. The females of this bee have a cavity on the upper side at the base of the abdomen, and in this cavity are constantly found examples of a mite, *Greenia*. The object of choosing this curious abode is at present unknown.

Another specimen of great interest in this case is the spoon-shaped entrance tube made by a very small stingless bee, *Trigona collina*, from Singapore, presented by Mr. H. N. Ridley. These bees live together in enormous numbers. They build in the hollows of old trees. The nest consists of an irregular mass of large cells and galleries made of resin. In the centre are the small breeding cells made of wax. Many of the large cavities in the resinous part are filled with pollen, stored for food. The entrance to the nest is by means of a tube such as that shown in the Table-case. The resin of which these nests are built is collected by these small bees in such large quantities that the masses are of commercial value. It is known in the market as "damar." In Burmah it is called "poonyet" or "pwai-nyet." A large mass weighing fifteen pounds is shown at the bottom of Wall-case 16.

Order DIPTERA.

The insects of this order are called Flies, and with them the Fleas are associated. They undergo a complete metamorphosis. The perfect insect has the head free, the attachment to the thorax being very slender. The thorax is compact and the union of the prothorax, mesothorax and metathorax is so complete that their limits are to a certain extent problematical. Two kinds of mouth parts are met with. The first in which the mandibles and maxillæ are very long and needle-shaped, enclosed in the labium which forms a sheath, as in the gnats; the second in which the mandibles and maxillæ are not manifest, whilst the labium is a soft fleshy organ, concealed in the mouth cavity when at rest, but, being jointed, capable of being extended when the insect is feeding. The Common House-fly is a good example of the second type.

The larvæ are grubs or maggots, for the most part without legs, and with very small heads. A few examples are exhibited in Table-case 49. The larvæ of gnats, however, which live in water have large heads and well-developed mouth parts, and are of quite a different

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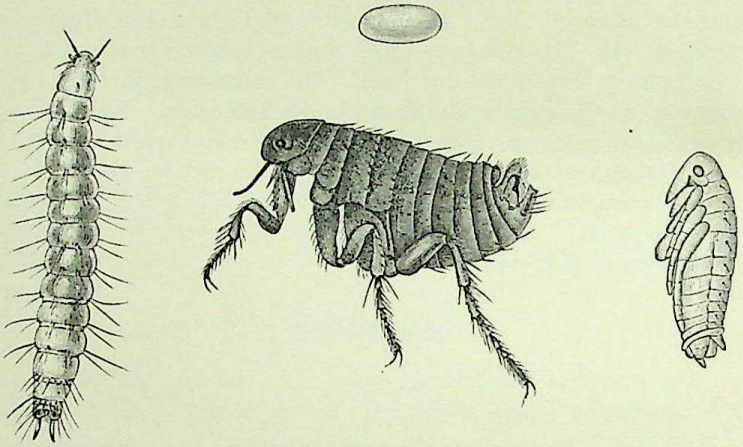
character. They are extremely active. Drawings of some of the most interesting species are exhibited in Table-case 49. The pupæ are very variable.

Table-case 49.

In Table-case 49 will be found a few examples of Fleas (*Pulicidæ*), with drawings of the egg, larva and pupa of the Common Flea (*Pulex irritans*) (fig. 59).

A considerable number of different kinds of fleas are known. Most of them live on Mammals and Birds, or are associated with them. The larvæ often breed in birds' nests, etc. The largest known flea, *Hystrichopsylla talpæ*, is found in the nests of moles and field mice.

Fig. 59.

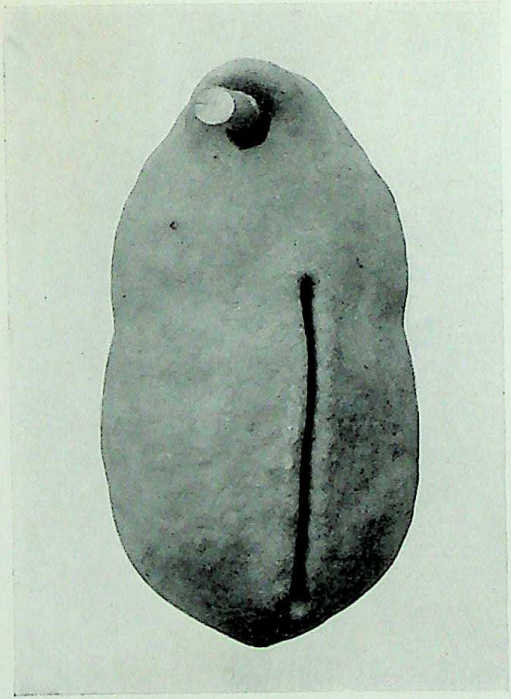


Egg, larva, pupa and imago of the common flea (*Pulex irritans*).
(Enlarged 20 times.)

The Common Flea breeds in neglected dirty houses, and the larvæ, which are very active little creatures, have been found in fluffy matter that had been allowed to collect between floor boards; also in old wooden bedsteads.

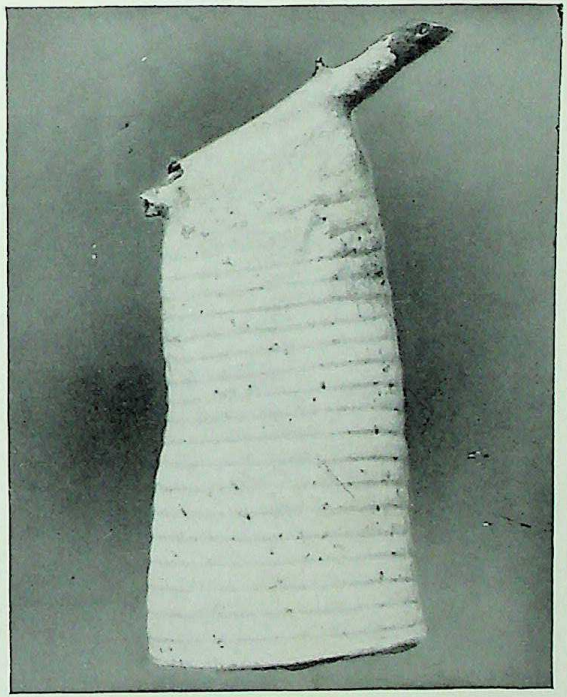
The "Jigger" Flea (*Sarcopsylla penetrans*) is a much smaller insect of a yellowish colour. It buries itself in the flesh of small animals and man. It particularly attacks the toes, and if not speedily removed causes a severe wound. Its body, partly by sucking moisture and partly by the development of the eggs, becomes greatly swollen, sometimes to the size of a small pea (fig. 60). It is a native of tropical America, but has been introduced into Africa,

Fig. 54.



NEST OF A WASP, BUILT OF CLAY (502).
$\frac{1}{4}$ NAT. SIZE.

Fig. 56.



NEST OF CARD-MAKING WASP (*Chartergus chartarius*) (575).
$\frac{1}{6}$ NAT. SIZE.

(Photographed from specimens in the Museum.)

[*To face p.* 54.

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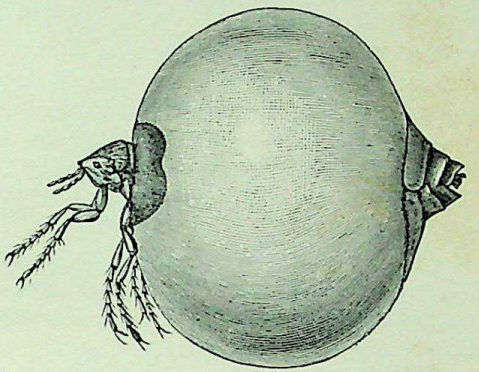
where it has spread rapidly. It has also been found in Madagascar and China. The natives in Africa who neglect to remove them frequently lose their toes in consequence.

Perhaps of all insects flies are man's greatest enemies, injuring his crops, fruit trees and vegetables, whilst others attack domestic animals, or are the means of conveying disease.

They are very diverse in their habits, even in the same family.

The *Cecidomyiidæ* are extremely small delicate flies. The larvæ of many species form galls, or swellings in the stems of plants. *Oligotrophus annulipes* (*Hormomyia piligera*) forms hairy tubercles on the upper surface of beech leaves (*see* model no. 87 on the east side of the gallery). *Contarinia tritici*, a Corn Midge, is injurious

Fig. 60.



Jigger flea (*Sarcopsylla penetrans*). Female with the abdomen distended. (Enlarged 10 times.)

to oats and barley. *Mayetiola* (*Cecidomyia*) *destructor*, the Hessian Fly, often causes serious damage to barley in some parts of the world. In England it appears to be kept in check by the numerous parasites to which it is subject.

Bibionidæ.—The larvæ of *Bibio* live on decaying vegetable matter in the earth; and when they come in contact with the living roots, they eat these. In this way, *Bibio hortulanus*, sometimes called a Fever Fly, does considerable damage to hops. The flies often appear in great numbers in the spring for a few days, and are seen crawling and tumbling about on the ground.

Culicidæ.—Gnats, for which the Spanish word, mosquito, is often used, have of late years come much into notice in consequence of

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their biting habits, and the discovery of the part played by them in conveying disease, with which the species of *Anopheles* are specially connected.

Tipulidæ.—Daddy-long-legs, or Crane-flies.—The larvæ, which are called Leather-jackets, live on roots, and sometimes do considerable mischief to lawns and root crops. Some species live in decaying wood and other vegetable matter.

The *Asilidæ* and *Empidæ* are predaceous. They live on other insects which they capture, pierce with their rather short, strong proboscis and suck dry.

The *Syrphidæ*, or Hover-flies.—The larvæ of these flies are very diverse in their habits. Some of them are beneficial, as they feed on Aphids (Green-fly). They somewhat resemble leeches in form, and may often be found among the Aphids on roses or on fruit trees, &c.

The larvæ of *Eristalis* and its allies are totally different. They live in water saturated with decaying matter and filth. In order to obtain air the larva is provided with a long tube-like tail, which is capable of being extended for a considerable distance to reach the surface of the water, whence these larvæ have been called rat-tailed maggots. The larvæ of *Volucella* live in the nests of humble-bees and wasps. Those of *Merodon* feed in narcissus bulbs, and sometimes cause serious loss.

Tachinidæ.—The larvæ of the majority of *Tachinidæ* live in caterpillars. This they do without killing the caterpillar until they are fully grown, when they pierce through the skin of the host, and almost immediately assume the pupa form.

Œstridæ.—This family is of small extent but of great importance, since the larvæ live at the expense of vertebrate animals. *Gastrophilus* larvæ, called "bots," find their way into the stomachs of horses. The larvæ of *Hypoderma lineatum* and *H. bovis*, the Ox Warble flies, are found under the skin on the backs of oxen, whilst those of *Œstrus ovis*, the Sheep Bot, are developed in the nasal and frontal sinuses of sheep.

Another group of flies of considerable interest are the *Hippoboscidæ*, which live on mammals and birds. *Hippobosca equina*, known as the Forest Fly, is found on horses; *Lipoptena cervi* on deer. *Stenopteryx hirundinis* attaches itself to the house-martin. *Melophagus ovinus*, another member of this family, is known by the misleading name of Sheep-tick. It is a curious wingless insect, which lives among the wool of sheep, and when numerous has an injurious effect on the fleece.

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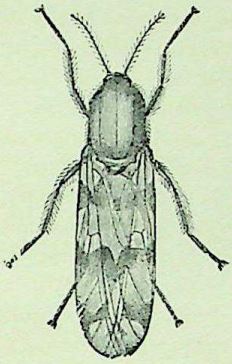
There are perhaps no insects more remarkable than the species of *Nycteribiidæ*, which are spider-like wingless creatures with very long legs and large curiously-formed claws, and are parasitic on bats. Another very small, closely-allied insect which should be noticed is *Braula cæca*, which attaches itself to bees.

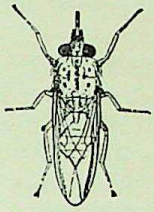
Considerable attention has been given of late to the biting and blood-sucking flies. Besides the gnats already referred to, some of the most troublesome are the biting midges: *Culicoides pulicaris* is one of the commonest (fig. 61). Species of *Simulium* are also serious pests in many localities. Specimens are exhibited in Table-case 50. Table-case 50.

Fig. 61.



Culicoides pulicaris.
(Greatly enlarged.)

Fig. 62.



Glossina longipennis.
(Slightly enlarged.)

Among the *Tabanidæ*, or Horse-flies, species of *Hæmatopota* and *Chrysops* are well-known biters, while *Stomoxys*, a genus of blood-sucking *Muscidæ*, includes several extremely troublesome and widely distributed species. Closely allied insects are the Tsetse-flies, *Glossina*, which are a serious menace to the development of Africa, since, by means of their bite, the parasites causing sleeping sickness and nagana (Tsetse-fly disease among animals) are conveyed (fig. 62). There are several species.

A small series of flies will be found in Drawers 16–19 of a cabinet on the west side of the gallery.

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Order COLEOPTERA.

The insects of this Order are called Beetles. They have a complete metamorphosis. The head is imbedded in the prothorax, which is very large. The front wings, called elytra, are not used in flight, but are hard and serve as covers to the hind wings, which are folded in a complex manner beneath them. When at rest they meet in a straight line down the back and do not cross one another.

They are commonly divided into twelve Sub-Orders, the principal characters for distinguishing which are explained by drawings and specimens arranged in a tabular form in Table-case 51. These Sub-Orders are again divided into many families, a few of which are illustrated in Table-cases 52, 53 and 54. A series of specimens will be found in drawers of a cabinet on the east side of the gallery.

Table-cases 51–54.

The larvæ are generally soft-bodied grubs living in concealment —Series of specimens illustrating the metamorphoses of *Melolontha* (129), *Propomacrus* (131), *Oryctes* (135), *Stenodontes* (137), *Spondylus* (139), and *Aspidomorpha* (143) are shown in Wall-case 8.

Wall-case 8.

Some problems connected with the geographical distribution of animals are suggested by beetles arranged upon maps placed on the West wall.

Most of the British Beetles are shown in the Hereward Dollman collection on the west side of the gallery, and a selected series of exotic representatives of the Order is contained in cabinets on the east side.

Some of the principal families of beetles are the following :—

The *Cicindelidæ* are exceedingly active predaceous beetles, of which the British species are known as Tiger-beetles. Their larvæ form perpendicular shafts in dry soil, and lie in wait to prey upon passing insects. Some of the tropical forms are arboreal and the larvæ of *Collyris* make their tunnels in the twigs of shrubs by boring a hole, through which they remove the pith.

The *Carabidæ*, Ground Beetles, are predaceous, most of them foraging by night, and lying hidden by day under stones, in crevices, etc. A remarkable exception to this rule is *Zabrus gibbus*, which eats the ears of corn. Several genera, e.g., *Brachinus* and *Pheropsophus*, have the power of extruding a drop of volatile and explosive fluid by which they disconcert their pursuers, whence their popular name "Bombardier Beetles." In *Anthia*, *Graphipterus* and

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other genera the fluid is not explosive but acid, and causes pain and discoloration.

Paussidæ possess the same crepitating faculty. They are curious beetles which live in the nests of ants, and seem to secrete a sweet substance which is very agreeable to their hosts. All the species (about 300 are known) are easily recognised by the extraordinary forms assumed by their antennæ.

The *Gyrinidæ*, Whirligig Beetles, skim over the surface of ponds and rivers by means of their paddle-shaped middle and hind legs. The front pair form prehensile organs for seizing the insects upon which they feed. The larvæ live in the water.

The *Dytiscidæ* are adapted to a purely aquatic life, although able to fly well. They carry a supply of air between the elytra and the back, where the spiracles are situated. They also are predaceous.

The *Staphylinidæ* are very ready fliers, although their wings fold into a very small space and the wing-covers are very short. They include a multitude of small species, and the insects which so often fly into the eyes on summer days and cause them to smart, commonly belong to this group, especially species of *Oxytelus*.

The *Silphidæ* are chiefly carrion-feeders, and the species of *Necrophorus* have the curious habit of burying small carcases which they find upon the ground, by digging away the earth from beneath them. Their eggs are afterwards deposited upon them and the larvæ feed in security.

Coccinellidæ, or Ladybirds, are amongst the most valuable of all insects to agriculturists, most of them feeding both as larvæ and imagines upon the prolific *Aphidæ* and *Coccidæ*, which work havoc among so many crops. When other methods of extirpating these have failed in various colonies, the introduction of certain kinds of *Coccinellidæ* has, in some cases, proved very successful.

The Lamellicorns include many of the largest and most striking insects. Many species are very destructive to trees and crops. The Cockchafer, *Melolontha vulgaris* (see Wall-case 8, No. 129) is one of these. It eats the leaves of oaks and other trees, but the larvæ cause still more serious damage by destroying the roots of cultivated crops. They generally pass three years in the ground before their development is complete.

Many *Scarabæidæ* are dung-feeders, like the long-familiar ball-rollers of the Mediterranean, Africa and the East. The ball when made is rolled with the hind legs until a sheltered spot is found where it can be consumed in peace. For the young a hole is

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excavated underground and a quantity of the food-material carried down and worked into a ball, in which a single egg is laid. The ball is cased with clay, which retains the moisture, and afterwards serves as a cocoon. A loosely covered spot at the top admits sufficient air for respiration. Some of the cells, examples of which made by species of *Heliocopris* and *Catharsius* are exhibited, are of great size and weight. The two parents seem to co-operate in the labour of construction, and the nest is sometimes guarded by the mother during the development of the young.

The *Passalidæ* are found in tropical climates beneath bark or within decaying wood, upon which they feed. The two parents and larvæ of different ages are found together, the adult beetles gnawing the wood and preparing it for their young, which seem unable to exist without them. The larvæ are remarkable in being apparently four-legged, as the hind pair of legs are extremely small and serve as part of a sound-producing instrument. The claws of the hind leg scrape against a microscopically ridged plate at the base of the middle leg.

The *Lucanidæ*, or Stag-beetles, are well known for the great enlargement of the head and jaws of the males. Most of them feed in rotten wood during the two or three years of larval life, but the large species, *Odontolabis siva*, cocoons of which are shown, feeds in the thatch of houses in the East, and the cocoons are made of gnawed pieces of this fastened together.

Ptinidæ and *Bostrichidæ* are exceedingly destructive to dry timber, woodwork and furniture, through which their larvæ tunnel until rapidly succeeding generations reduce it to powder. A piece of an oak rafter from the roof of Arundel Church, completely honeycombed by *Xestobium tessellatum*, is exhibited. These beetles are the mysterious Death-watches of old houses. By striking the front of their head in regular time against resounding wood they produce a ticking noise which in a silent room is very distinct. It was no doubt more often heard in days when wainscoting was more common than in the present day, and it is not surprising that it was believed to be supernatural in the absence of any visible cause.

A smaller species, *Anobium punctatum*, is the one generally responsible for the "worm-holes" so often seen in old furniture. These are the exits by which the beetles have left the wood when their development was completed and their tunnellings over. *Anobium paniceum* is also found in houses, where it attacks provisions, and even books, boots and leather articles allowed to rest

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long undisturbed. A small dried loaf and a book riddled by it may be seen in the table-case.

The *Lampyridæ* include the Glow-worms and Fire-flies. The males are always winged and the females often grub-like, but all forms, including the eggs, are luminous. They are predaceous insects, most, if not all, of them preying upon slugs and snails.

The *Elateridæ* are better known in the larval stage, as the Wire-worms so injurious to crops, than in the adult form, when they are often called Skipjacks, or Click beetles. The species of one Tropical American genus, *Pyrophorus*, are luminous and, like the *Lampyridæ*, are called Fire-flies. The light proceeds from spots upon the upper surface of the thorax. In the *Lampyridæ* it comes chiefly from the lower surface of the abdomen.

Most of the *Buprestidæ* are very brilliantly coloured, and the wing-covers of some of them are often used in Oriental embroideries. Most of their larvæ are long, flattened, legless grubs which feed in timber. The spiral burrow made in a bough of the Cork-oak in France by a species of *Corœbus* is exhibited.

The *Meloidæ* are parasites, feeding during the larval period upon the eggs, young, or stored food of other insects. *Meloe proscarabæus* is a common British species. It undergoes several extraordinary changes of form before reaching the pupal stage. The mature insects feed upon foliage, and are protected from birds and insect-eating animals by a caustic secretion which they can exude and which is extracted and used medically under the name of cantharidine.

The *Curculionidæ*, or Weevils, are an enormous family of vegetable-feeders, many of which cause serious injury to cultivators. One of the largest of them is the Palm-weevil (*Rhynchophorus*), which destroys the interior of the Coconut Palm, working upwards from the roots and ultimately reducing the tree to a shell.

A very injurious species found in this country is *Pissodes notatus*. A small piece of young Austrian pine infested by this insect is exhibited. An entire plantation of young trees of this species at Dorchester was destroyed. The habits of several other British Weevils are illustrated by models on the East side of the Gallery. *Ceuthorrhynchus sulcicollis* (55) produces excrescences upon turnips or cabbage stems within which its larvæ feed. The Apple-blossom Weevil, *Anthonomus pomorum* (53), kills the flower buds of the apple tree, one egg being laid by the mother in each bud. The female of *Attelabus curculionoides* (57) cuts oak leaves across the

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middle, leaving the mid-rib intact. The terminal half then falls back and is neatly rolled into a closed cylinder within which an egg is placed. The larva lives and feeds within this shelter, eventually falling to the ground to pupate. *Rhynchites betulæ* (59) treats birch leaves in a similar way, but the cell is sugar-loaf shaped instead of cylindrical.

Scolytidæ are small beetles which bore into trees, the larvæ of most of them feeding upon the soft layer immediately beneath the bark. The borings of several species of *Scolytus* are shown. The female drives a tunnel just beneath the bark and along it places her eggs at regular intervals. Each little grub upon hatching proceeds immediately to eat its way into the same layer, the tunnels increasing in diameter with the growth of the inmates, but always keeping separate, so that they become more and more oblique towards the end of the colony. Curious and beautiful patterns are traced in this way upon the surface of the wood. Certain other Scolytidæ live socially within cavities in tree trunks, feeding upon fungi which grow within the cavities and are even said to be cultivated by the beetles.

The Longicorns are wood feeders, attacking forest trees in every part of the world. They sometimes emerge from wood which has been in use for some time, and in which the larvæ have been concealed. Parts of the batten of a claret cask pulverised by *Hylotrupes bajulus* are shown, together with specimens of the beetle. Two other species shown sever small branches by gnawing a circular groove around them. This is done by the female when laying her eggs. The cut branch snaps off at the incision and the larva feeds within it as it lies upon the ground. In a model against the East Wall are shown branches of poplar attacked by *Saperda populnea*, the female of which lacerates the bark with her mandibles and deposits an egg at the injured spot. The larva enters the wood and feeds within the swelling produced.

The *Chrysomelidæ* are chiefly leaf feeders, and some of them, like the Colorado Potato Beetle (*Doryphora* 10-*lineata*), are very serious pests. That species, although it has been accidentally imported into this country and the Continent, has hitherto not succeeded in establishing itself permanently. The Mustard Beetle (*Phædon cochleariæ*), a common British species which destroys the leaves of mustard, is shown in a model. Most of the members of this family possess offensive juices which protect them from the attack of insectivorous animals, and *Diamphidia nigro-ornata*, of which larva, cocoons and

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imago are shown, is so poisonous that the natives of Ngamiland use it for poisoning their arrows.

The *Cassididæ* or Tortoise-beetles. Several species are shown, together with the remarkable egg-cases of several South African forms. Each egg is contained in a separate cell in a beautiful honeycomb-like structure, gradually built up by the female from a glutinous secretion. The larvæ have a curious pair of long tails, which are carried over the back. The skins cast successively, four in number, are held, together with the excreta, by these tails, and form a kind of mask throughout the larval stage.

Order RHYNCHOTA.

This Order includes the Bugs, Cicadas, Froth-flies, Aphids, and Scale Insects.

They undergo incomplete metamorphosis. The head is imbedded in the prothorax, which is very large. The mouth is modified so as to form a long proboscis, formed for piercing and for sucking juices; it lies beneath the body when at rest, directed backwards.

They are divided into two Sub-Orders, the HEMIPTERA and HOMOPTERA.

A series of specimens, with explanatory drawings and labels, is in course of preparation, and will be exhibited shortly in Table-cases 55 and 56. Table-case 55.

The HEMIPTERA have the base of the front wings leathery, the apical part membranous, crossed over one another when at rest. This Sub-Order includes all the Plant Bugs, Tree Bugs, House Bug, etc.

A small series of specimens will be found in Drawers 9–12 in a cabinet on the west side of the gallery. They live on the juices of plants. A minority, however, attack and suck moisture from caterpillars and other insects, especially species of the family *Reduviidæ*, and some will bite human beings, the bite in some cases being as painful as the sting of a wasp. *Sirthenea stria* is one of these in Trinidad. *Triatoma infestans* is mentioned as being very troublesome, and *Triatoma sanguisuga* causes great pain and inflammation. These are South American.

The Common Bed Bug (*Cimex lectularius*) feeds by sucking blood; it is often found hiding by day behind pictures left undisturbed and behind wainscots. This species is not met with in

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England away from houses, but three species, *Cimex colombarius*, *C. hirundinis* and *C. pipistrelli*, are found in the nests of pigeons, swallows and bats respectively.

Aspongopus nepalensis, a large species, which hides itself under stones in dry river beds in North India, is sought for and eaten by the natives.

The HOMOPTERA have wings of the same texture throughout, held roof-like when at rest. This Sub-Order includes the Cicadas, Froth-flies, Aphids, etc. A small series of specimens will be found in Drawers 13–15 in a cabinet on the west side of the gallery.

The Cicadas have brought themselves under notice from the earliest times by the sounds that they produce. This sound is produced by a complex structure at the base of the abdomen. In their early stages they live under ground on roots. The pupæ are remarkable-looking creatures.

The *Fulgoridæ* include the Lantern Flies, so called on account of the curiously developed heads of some of them. Many members of the family secrete a white waxy substance from their abdomens. One of the most remarkable is *Phenax*. The young of species of *Flata*, covered with this white waxy substance, are sometimes found in masses. A beautiful example is exhibited.

The wax secreted by *Fulgoridæ* is used for making candles in China.

The *Membracidæ* are noteworthy on account of the very curious shapes taken by the pronotum.

To the *Cercopidæ* belong our British Froth-flies and their allies. One of the commonest species, *Philaenus spumarius*, is well known as living on garden plants. In their early state they surround themselves with white froth which consists of the liquid excrement blown into bubbles by air forced into it by pressure upon the sides of a chamber lying along the underside of the abdomen. The full-grown insects, called Frog-hoppers, are very injurious. They constantly prick the young leaves in order to suck the juice. Afterwards, as the leaves grow, these pricks become holes and the leaves often get much withered.

The *Aphidæ* are known as Plant-lice or Green-fly.

The *Coccidæ* are called Scale Insects from the scale-like appearance of the females of many of the species. The males are delicate insects with one pair of wings only. Examples of the males and females of the largest known species, *Lophococcus maximus*, from Rhodesia, are exhibited.

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